United States Department of the Interior

FISH AND WILDLIFE SERVICE
Pacific Islands Fish and Wildlife Office
300 Ala Moana Boulevard, Room 3-122,
Honolulu, Hawaii 96850

In Reply Refer To:
01EPIF00-2015-F-0025
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Captain Joseph A. Campbell
Deputy Director, Joint Guam Program Office
Office of the Assistant Secretary of the Navy (EI&E)
Joint Guam Program Office, ASN (EI&E)
201 12th Street South, Suite 700
Arlington, Virginia 22202

Subject: Biological Opinion for the Department of Navy's Relocation of the U.S. Marine Corps from Okinawa to Guam and Associated Activities on Guam

Dear Captain Campbell:

This document transmits the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) addressing the effects of the subject action as proposed by the Department of the Navy (DON) to the federally listed Mariana fruit bat (*Pteropus mariannus mariannus*), Mariana crow (*Corvus kubaryi*), Guam Micronesian kingfisher (*Todiramphus cinnamominus cinnamominus*), Guam rail (*Gallirallus owstoni*), Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*), *Serianthes nelsonii*, *Bulbophyllum guamense*, *Cycas micronesica*, *Dendrobium guamense*, *Heritiera longipetiolata*, *Tabernaemontana rotensis*, and *Tuberolabium guamense*. The Opinion also addresses adverse effects to critical habitat for the Mariana fruit bat, Mariana crow, and Guam Micronesian kingfisher. The Opinion was prepared in accordance with the requirements of section 7 of the Endangered Species Act (ESA) of 1973 as amended (16 U.S.C. 1531 *et seq.*). The DON is the designated lead Federal agency for this consultation. This Opinion completely supercedes and replaces the 2010 DON Biological Opinion (2010-F-0122) and the July 31, 2015, DON Biological Opinion (2015-F-0025).

In addition, pursuant to the Cooperative Agreement between the U.S. Air Force, DON, and the Service for the establishment and management of the Guam National Wildlife Refuge, we have provided technical assistance on *Psychotria malaspinae* (Appendix A) and coordination regarding potential impacts to the Guam National Wildlife Refuge Overlay from the proposed project. This consultation reviews anticipated effects to the federally listed species and their terrestrial habitats, including listed species habitat, on Guam. In this consultation, habitat is

defined as the habitat that is currently suitable to support the survival and recovery of listed species.

Per meetings with your staff on October 1 and 2, 2015, the DON has requested our concurrence with your determination that the subject action is not likely to adversely affect the endangered humped tree snail (*Partula gibba*), Guam tree snail (*Partula radiolata*), and fragile tree snail (*Samoana fragilis*). Our assessment of project effects to these species are addressed in the informal consultation (Appendix B). It also includes our response to your October 1, 2014 letter, requesting our concurrence with your determination that the subject action is not likely to adversely affect the endangered Mariana swiftlet (*Aerodramus bartschi*), threatened green sea turtle (*Chelonia mydas*), and endangered hawksbill sea turtle (*Eretmochelys imbricata*) pursuant to section 7 of the ESA.

This Opinion is based on information provided in your October 1, 2014, letter and biological assessment; updates to the biological assessment; a conference assessment; letters that include information on project description and species locations; email correspondence and discussions between the Service and DON; site visits and our files. A complete project file for this consultation is in the Pacific Islands Fish and Wildlife Office in Honolulu.

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A. CONSULTATION HISTORY

September 8, 2010. The Service issued the Biological Opinion (BO) for the Joint Guam Program Office (JGPO) Relocation of the U.S. Marine Corps (USMC) from Okinawa to Guam and Associated Activities on Guam and Tinian (2010-F-01222; hereafter, 2010 DON BO) to the DON.

March 13, 2012. The DON informed the Service that they were proposing changes to the project as described in the 2010 DON BO. The DON discussed that the proposed live-fire training range complex (LFTRC) may be located along Route 15 or within the Naval Munitions Site (NMS) on Guam. The DON explained that they were in the process of preparing a draft supplemental environmental impact statement (Draft SEIS) that would include potential locations for the LFTRC on Guam.

September 17, 2012. The DON submitted their annual report on the implementation of conservation measures for the 2010 DON BO. The DON explained to the Service the implications of the 2012 National Defense Authorization Act (2012 NDAA) on the 2010 DON BO. The DON stated there would be a reduced force and number of dependents moving to Guam; and the 2012 NDAA did not affect the existing awards for military construction but affected all future military construction projects, including some of the conservation measures in the 2010 DON BO. The DON provided a draft letter requesting an amendment to the 2010 DON BO.

September 20, 2012. The DON provided the Service with a draft conservation measure tracking sheet which showed the project activities (as described in the 2010 DON BO) that were affected by the 2012 NDAA.

October 11, 2012. The DON modified its Draft SEIS to accommodate changes to the proposed force structure and number of dependents being relocated to Guam, and the proposed alternatives for the LFTRC changed from information provided in March 2012 to include the LFTRC at Northwest Field (NWF) located on Andersen Air Force Base (AAFB).

October 12, 2012. The Service and DON discussed the proposed changes to the project and whether the changes constituted an amendment or a reinitiation of the 2010 DON BO. The Service stated that the 2010 DON BO would need to be reintiated due to substantive changes in the scope of the action.

January 30, 2013. The DON, the Service's Pacific Regional Office (RO), and the Regional Solicitor's Office via a conference call discussed the subjects of extirpated species consultation and the need to reinitiate versus amend the 2010 DON BO for the DON's " interim actions" that would occur between 2013 and 2015.

April 3, 2013. The Service received DON's request to reinitiate the 2010 DON BO and received the *Biological Assessment for the Reinitiation of Consultation for the Proposed Military Relocation to Guam; Fiscal Years 2010–2015.* The DON determined that the only federally listed species affected by the DON activities between fiscal years 2010 and 2015 was the Mariana fruit bat. The DON determined that the project "may affect, but is not likely to

adversely affect" the Mariana fruit bat.

April 9, 2013. The DON and the Service met to discuss DON's request to reinitiate the 2010 DON BO. The DON delivered a presentation on the proposed adjustments to the project, which included the relocation of approximately 5,000 USMC personnel and 1,300 dependents and the LFTRC alternative located at NWF, AAFB on Guam. The DON requested the reinitiated consultation only address the project activities that would be conducted between 2010-2015. The discussion focused on how to best address the "interim actions" that would occur between 2013 and 2015; the inclusion of the extirpated species, the Guam Micronesian kingfisher, Guam rail, and the Mariana crow, in the consultation; the status and implementation of conservation measures; and brown treesnake interdiction measures.

May 3, 2013. The Service acknowledged the receipt of the DON's request to reinitiate the 2010 DON BO. The Service determined that there was insufficient information to initiate consultation. The Service questioned the need to determine if reinitiation of consultation or an amendment would be the best mechanism to address DON's changes in the proposed action. The Service requested a table with a list of project activities and their associated or linked conservation measures that would mitigate impacts to the listed species. The Service also requested that the brown treesnake control and interdiction measures in the 2010 DON BO remain in the consultation.

May 7, 2013. The Service provided a draft table that tracked the conservations measures that should have or have been implemented as required by the 2010 DON BO.

May 30, 2013. The DON responded to the Service's letter of May 3, 2013, and provided the requested table (hereinafter "crosswalk table"). The crosswalk table listed project activities and linked conservation measures that avoid, minimize, and compensate for the impacts associated with the interim actions. DON also provided a color coding of all the conservation measures included in the 2010 DON BO to delineate which conservation measures have been implemented and those measures which have not been triggered or will not be implemented based on the proposed adjustments to the action.

June 13, 2013. The DON requested a meeting to discuss the crosswalk table and for the Service to provide the rationale to support including the Guam Micronesian kingfisher, Mariana crow, and Guam rail in the consultation.

July 8, 2013. The Service and DON met to discuss the following: 1) The Service discussed staffing workload and recommended a programmatic approach to the Marianas related Department of Defense (DoD) consultations being submitted to the Service office in the next 18 months; 2) The Service requested that the Guam Micronesian kingfisher, Mariana crow and Guam rail be included in the consultation. The DON requested the legal rationale requiring section 7 consultation on extirpated species. The Service stated they had a draft white paper in development that would address DON's request; 3) Standardized language for brown treesnake interdiction and rapid response efforts; 4) The Service acknowledged that they requested a reinitiation of the 2010 DON BO, which resulted in DON's April submittal of a reinitiation request; however the Service thought an amendment may be more appropriate considering the

interim actions are within the scope of the consultation; and 5) Both parties agreed further clarification and discussion on the crosswalk table were needed.

August 19, 2013. The Service provided rationale to the DON regarding the requirement under the ESA to consult on project impacts to the Guam Micronesian kingfisher, Mariana crow, and Guam rail.

August 22-23, 2013. The Service submitted comments on the crosswalk table to DON. Email correspondence was exchanged between the Service and DON on the crosswalk table.

August 28, 2013. The DON provided their reasons why they disagreed with the Service's August 19, 2013, rationale.

September 10, 2013. The DON requested a species list for this consultation, the DON Relocation of the USMC from Okinawa to Guam and Associated Activities on Guam (proposed project). The DON also provided the Service with the preliminary drafts of chapters 1 and 2 of the Draft SEIS.

September 11, 2013. During a conference call between DON and the Service, the participants agreed that the extirpated species issue required elevation to the Service's RO and Regional Office of the Solicitor.

September 30, 2013. The Service provided the DON with a species list of federally listed species and information on critical habitat for the proposed project.

October 1, 2013. The Service notified the DON that the Service completed their review of the August 28, 2013, correspondence from the DON. The Service determined that both agencies were at an impasse regarding the issue on consulting on project affects to the Guam Micronesian kingfisher, Mariana crow, and Guam rail. The Service informed the DON that this issue would be elevated to the Service's RO.

December 3, 2013. The DON and the Service discussed the development of the biological assessment for the proposed project and the initial approach on the conservation measures.

December 2013. The DON's Assistant General Counsel for Energy, Installations, and Environment reconfirmed the Service's RO position in discussions with the Department of the Interior's Deputy Solicitor for Fish, Wildlife, and Parks. The date of "December 2013" and meeting description are referenced in a January 30, 2014, letter from the DON to the Service.

January 30, 2014. The DON requested to terminate their request for reinitiation of the 2010 DON BO for their interim actions as described in their April 3, 2013, biological assessment.

February 24, 2014. The Service replied that they would consider the January 30, 2014, request from the DON; however before a decision could be made, the Service requested assurances that key conservation measures outlined in the Service's letter would be implemented per the requirements of the 2010 DON BO.

March 21, 2014. The DON acknowledged receipt of the Service's February 24, 2014, response and requested a meeting to discuss issues outlined per the January 20, 2014, and February 24, 2014, correspondences.

April 15, 2014. The Service and DON met and discussed the following: The DON will reinitiate the 2010 DON consultation by submitting one consolidated biological assessment for the entire relocation to include 2010-2015 interim actions identified in the DON's request to consult, dated April 3, 2013, and the changes to the project (the reduction in USMC relocating to Guam and the proposed LFTRC and NWF). The DON will assess impacts and proposed conservation measures for all project activities and actions associated with the project.

May 6, 2014. A teleconference occurred between DON and the Service as a follow up to the April 15, 2014, meeting. Items discussed included the Service's review of completed and ongoing mitigation to assess interim legal compliance and the Service's and DON's points of contacts for the consultation.

May 15, 2014. The Service and DON discussed the twenty-three species located on Guam and the U.S. Commonwealth of the Northern Mariana Islands (CNMI) that were under consideration for listing as either threatened or endangered under the ESA. The Service also mentioned they are considering designating critical habitat for these species (if listed) and revising critical habitat for currently listed species on Guam and the CNMI.

May 23, 2014. The Service and DON met to discuss the development of the biological assessment, including preliminary thoughts on mitigation for habitat loss.

June 26, 2014. The DON discussed including mitigation in the consultation for the demolition and related function of the ungulate management fence at NWF, AAFB. The ungulate management fence is a conservation measure and requirement of the Intelligence, Surveillance, Reconnaissance, and Strike Capability (ISR) Biological Opinion that was issued to the Air Force.

July 22, 2014. The Service and DON discussed the status of this consultation and related briefings to regional and headquarters Service and DON counterparts; the status of the predictive modeling for the U.S. Department of Agriculture, Wildlife Service's (USDA) brown treesnake interdiction costs; and future coordination between the Service and DON on the project's biological assessment.

September 16, 2014. The DON provided a presentation of the general contents of the biological assessment that would be submitted to the Service on October 1, 2014. During the meeting, the DON explained the main differences between the project as described in the 2010 Final EIS and the Draft SEIS. Other topics that were discussed were the species that would be included in the consultation and potential project impacts to their habitat, project construction chronology, training activities at the NMS, conservation measures, and proposed project activities on critical habitat on Guam.

September 24 and 26, and October 15, 2014. The Service and DON discussed and corresponded via email regarding available sea turtle literature and information.

October 1, 2014. The DON transmitted a letter, dated September 30, 2014, requesting formal consultation on the potential adverse effects of the proposed DON military relocation to Guam to the Guam Micronesian kingfisher, Mariana fruit bat, Mariana crow, and Guam rail. The DON also requested informal consultation on the Mariana gray swiftlet, green sea turtle, hawksbill sea turtle, and the *Serianthes nelsonii*. The DON's letter included an enclosed biological assessment for the proposed action: the *Biological Assessment for the Re-Initiation of Consultation regarding the Proposed Military Relocation to Guam*, dated October 1, 2014 (hereafter, referred to as the BA).

October 2, 2014. The DON requested a map of the proposed listed species locations on Guam from the Service.

October 22, 2014. In response to the DON's request, the Service provided a map of the proposed threatened and endangered species' locations on Guam.

October 31, 2014. The Service acknowledged the receipt of the September 30, 2014, DON letter and BA for the proposed DON military relocation to Guam. The Service determined that the information in the 2014 DON BA was insufficient to reinitiate consultation and requested additional information from the DON on the proposed action necessary to initiate and complete this consultation. The Service outlined the requested information in a letter.

November 11, 2014. The DON transmitted a letter, dated November 7, 2014, and enclosure in response to the Service's October 31, 2014, request for additional information needed to reinitiate the formal consultation.

December 4, 15, and 19, 2014. The Service and DON corresponded via emails to further clarify the project description, and met to discuss mitigation for the loss of habitat on Guam as a result of the proposed project. During the December 19 meeting, the Service provided the DON with the *Framework for Mitigating the Impacts of Listed Species Habitat Loss on Guam*, dated December 19, 2014 (hereafter, referred to as the Mitigation Framework), and delivered a presentation on the Mitigation Framework.

December 19, 2014. The Service provided the DON with the updated Geographic Information System (GIS) layers for the recovery habitat for the Guam Micronesian kingfisher and Mariana crow.

December 19, 2014. The Service acknowledged receipt of the November 7, 2014, DON letter and enclosure and the December 19, 2014, DON email and table with the additional information necessary to initiate consultation. In these correspondences, the DON stated that the information on the peak noise levels for the proposed LFTRC would be provided to the Service on January 8, 2015. The Service also recognized the ongoing dialogue between the agencies on the project impacts to the *Serianthes nelsonii* at NWF; however the Service did not concur with DON's determination that the proposed action "may affect, but is not likely to adversely affect" the *S. nelsonii*. The Service recommended that the DON request formal consultation on the project effects to *S. nelsonii*. The Service agreed to initiate the consultation on January 8, 2015 in good faith that above issues would be resolved by this date.

January 8, 2015. The Service and DON, met at the Marine Corps Base Hawaii on Oahu. The DON and USMC presented information on noise levels associated with the machine gun range they proposed to build and operate at the LFTRC at NWF, AAFB on Guam. The Service agreed that the requested information on noise levels was received during this meeting. The DON agreed to change their determination from a "not likely to adversely affect" to "may affect, likely to adversely affect" for project impacts to *S. nelsonii*. The DON and Service also agreed to communicate more effectively regarding issues related to the project consultation.

January 16, 2015. The Service and DON met to discuss the status of the consultation and additional clarifications to the project description and conservation measures. The DON provided information on changes to the project description, including updated acreage of recovery habitat that would be impacted by the project and the timing of range construction activities based on the data provided by the Service on December 19, 2014. The Service and DON also discussed the impacts to the critical habitat on Guam. The Service stated that based on the review of the information on the noise levels, they did not concur with DON's determination that the proposed action would "not likely to adversely affect" critical habitat for the Guam Micronesian kingfisher, Mariana crow, and Mariana fruit bat.

January 28, 2015. The Service requested written information on the changes to the project description, as discussed on January 16, 2015, from the DON. On January 31, 2015, the DON provided information on the project description changes via email and further clarified this information in a meeting on February 6, 2015.

January 28 to February 11, 2015. Emails were exchanged among U.S. Geological Survey (USGS), Fort Collins; the Service; and the DON on the noise levels and potential impacts to the close population facility located at NWF, AAFB. On January 30, 2015, a meeting was held to discuss noise levels and provide information on the future access and coordination that would be needed to access the facility. As a follow up to the January 30, meeting, the DON provided a response via email to questions about access and operations to the closed population facility on February 3.

February 3, 2015. The Service and DON conducted a site visit to the proposed Finegayan mitigation site on Guam.

February 3, 2015. The Service, via an email, stated that DON's proposed clearing of critical habitat for the relocation of the Guam National Wildlife Refuge (GNWR) headquarters was not acceptable. The Service stated that they were willing to identify alternative(s) proposed relocation sites. In addition, the Service confirmed completing the final Biological Opinion by May 18, 2015.

February 6, 2015. The Service and DON discussed: the logistics of the inspections of the surface danger zone (SDZ) in beach areas within the GNWR prior to the operation of the LFTRC; an update (and increase) in the number of acres of habitat that would be lost per listed species; conservation measures for *S. nelsonii*; USMC training at the NMS; and the Mitigation Framework.

February 12, 2015. The DON provided a response to the Service's request for additional mitigation to compensate for the loss of recovery habitat, as presented in the December 19, 2014, meeting and the Mitigation Framework. The DON provided a process for habitat conservation in one comprehensive document, an integrated natural resource management plan (INRMP), which is a planning and execution tool for the Navy, Air Force, Marine Corps and Army and is approved by the Joint Region Marianas Commanding Officer. Identifying mitigation ratios in the INRMP provides an incentive early in the planning process to avoid impacting mitigation sites and the associated increased cost to the program. DON included chapters 5 and 6 of the Marine Corps Air Station (MCAS) Miramar INRMP to use as an example of how the DON proposes to address project and mitigation planning for this consultation and future DON consultations on Guam. The DON stated that the Joint Region Marianas (JRM) will incorporate conservation measures of the BO into the INRMP.

February 13, 2015. The Service received updated information on the total number of acres of habitat for the Guam Micronesian kingfisher, Mariana crow, Mariana fruit bat, Guam rail, and *S. nelsonii* that would be lost as a result of the proposed project from the DON.

February 13, 2015. The Service sent an email to the DON that included recommended conservation measures for *S. nelsonii.* On February 18 and 19 and on March 4, 6, and 10, the DON and Service discussed by phone and corresponded via email about the conservation measures for *S. nelsonii.*

February 18, 2015. The Service requested clarification on the brown treesnake interdiction and control measures. The Service and DON discussed and corresponded about these measures on February 20, March 18 and 19, 2015.

February 20, 2015. The Service provided a preliminary draft of the Consultation History and Project Description sections of the BO for DON's review.

February 24, 2015. The Service and DON reconfirmed the due date of May 18, 2015, for the final DON BO. It was discussed that the due date of the draft BO for the Navy's review would be April 27, 2015. The Service and DON also discussed the importance of a conservation measure which included maintaining a minimum of 30 outplanted individuals of *S. nelsonii*, parented from the Guam (*S. nelsonii*) adult tree, to adulthood. The DON stated that JRM has the responsibility to manage the conservation measures in the BO through JRM's INRMP.

February 28, 2015. The DON sent updated maps depicting the peak noise levels as a result of the operation of the LFTRC to the Service.

March 1, 2015. The Service provided a draft description of the project activities (based on the BA) that are carried over from the 2010 DON BO into the proposed project for the DON's review.

March 3, 2015. The DON provided initial comments on the February 20, 2015, preliminary draft of the Consultation History and Project Description sections of this BO.

March 2-4, 2015. The Service and DON exchanged emails regarding the duration of the

proposed project. The DON described the duration of the proposed project as indefinite.

March 5, 2015. The Service and DON met to discuss the Guam Micronesian kingfisher recovery needs on Guam and the Service's analysis of the amount of available habitat for the kingfisher on Guam. The DON also went through the calculations on the peak noise levels at the LFTRC and the SDZ. The DON stated that the peak noise levels presented in a model during the January 8, 2015, meeting no longer presented a valid estimate on peak noise levels and would provide the Service with new information using the noise calculations presented during the January 8, 2015, meeting on the peak noise levels within the LFTRC and SDZ. The Service also stated that a noise monitoring study should be developed and implemented during the operations of the LFTRC to validate the noise calculations on the peak noise levels. The DON presented a mitigation concept that included protecting large amounts of habitat for the recovery of the Guam Micronesian kingfisher on DoD land, and it was discussed that the DON and the Service should work together to develop language to present as a conservation measure for the proposed project.

March 5, 2015. The Service provided a map of the recovery habitat that is needed to support the recovery of threatened and endangered species in northern Guam. The purpose of this map was to provide guidance and information to DON regarding recovery habitat (within DoD lands) that should be protected and set aside in conservation status, as mitigation, for the proposed project. On the same date, the DON submitted an ambient noise study for the LFTRC (DON 2015a).

March 7, 2015. The DON provided comments on the preliminary draft sections of the Consultation History and Project Description, including the 2010 DON carry-over activities, to the Service. The DON also provided additional information on the peak noise levels at the LFTRC. The Service requested DON provide the rationale of why the new information on peak noise levels should replace the previously submitted (on January 8, 2015) peak noise levels.

March 9, 2015. The Service and DON discussed the intent of the brown treesnake interdiction and control measures and *S. nelsonii* conservation measures, and other clarification to the draft project description including the introductory paragraph to the conservation measures. On the same date, the Service requested via email that DON provide the rationale of why the new information on peak noise levels should replace the previously submitted (on January 8, 2015) peak noise levels.

March 10, 2015. The DON submitted a request for initiation of a Conference Opinion on proposed federally listed species. The DON determined that the proposed project *would not likely adversely affect* proposed federally listed species.

March 12, 2015. The DON provided additional information on the description of the LFTRC and number of construction workers that would contribute to the population increase over the life of the project.

March 13, 2015. The DON provided a statement via email that the January 8, 2015, model on peak noise levels should be replaced with the new information submitted on March 5 and 7, 2015, to the Service. The DON explained that the most current information on the peak noise levels at the LFTRC is coupled with the attenuation as appropriate for the directional aspects of

position relative to the muzzle of the weapon, effects of humidity, vegetation, and a berm and an excerpt of the ambient noise study for the LFTRC (DON 2015a).

March 17 and 18, 2015. The Service requested information on the additional barriers that reduced the noise levels and effects on the listed species, as proposed by the DON on March 5 and 7. On March 19, 2015, the DON informed the Service that the additional barriers were intended to be Conservation Recommendations and would not be included in the Project Description. This change modified the DON's previous noise assessment provided on March 5, 2015.

March 17, 2015. The Service delivered a presentation to DON on the assessment of habitat in northern Guam for the recovery and survival of the Guam Micronesian kingfisher.

March 23, 2015. The Service and DON discussed conservation measures that would mitigate adverse effects to listed species as result of the proposed project. During this meeting, the DON stated the issue of concern was the Service's request that the DON should permanently set aside land for the recovery of the extirpated (listed) species (kingfisher, crow, rail) as mitigation for the proposed project. Given the broad implication of such an endeavor, the DON did not want to include their support of conserving land for future recovery of extirpated (listed) species on Guam as part of the proposed project. Both the DON and Service discussed establishing inter-agency conservation teams to work on commitments for land conservation. The DON requested that the Service include DON-drafted Conservation Recommendations, which would be submitted on March 25, 2015 to the Service, in the Biological Opinion.

March 24, 2015. The DON and Service discussed ongoing recovery efforts and requirements for the Guam Micronesian kingfisher.

March 25, 2015. The DON submitted proposed Conservation Recommendations to the Service.

March 27, 2015. The DON submitted via email revised conservation measures on project lighting requirements for the Mariana fruit bat and nesting sea turtles to the Service.

March 30, 2015. The DON via email clarified that the beach access road located outside the SDZ and northwest of the previously proposed new GNWR facilities would not be a stand-alone action and should be considered part of the proposed project. The DON stated that the development of the beach access road would result in the clearing of 1.72 acre (ac) of designated critical habitat for listed species on Guam. On April 1, 2015, the Service reiterated to the DON that the clearing of critical habitat on the fee simple land at the GNWR was unacceptable as stated in the Service's February 3, 2015, email to the DON. The Service offered to work with the DON to identify alternative(s) to the proposed relocation that does not affect land with wildlife habitat value.

March 31, 2015. The DON submitted additional comments on the February 20, 2015, preliminary draft of the Consultation History and Project Description sections. The DON stated that the comments were mainly editorial and suggested the Service address the comments when the DON received the complete Draft Biological Opinion for their review.

March 31, 2015. The Service and DON discussed that the DON-drafted Conservation Recommendations will not be a part of the biological analysis and the beach access road would not be part of the project description. The DON inquired if an action alert for jeopardy was being issued for the consultation. The Service replied that they were not able to answer this question because the analysis has not been completed. The Service stated that they would have a draft BO completed for the Service's internal review on April 17, 2015. In addition, both parties acknowledged that alternatives for the ungulate management fence per the ISR Strike BO would need to be further discussed.

April 13, 2015. The Service sent an email to the DON requesting clarification on their position on the reintroduction of native and listed species on DoD land on Guam. In this email, the Service stated that per a meeting on March 9, 2015, the Service and DON discussed reintroduction language (the same reintroduction language that was in the 2010 DON BO). During this meeting, the DON agreed that the reintroduction language could be included in the introduction paragraph to the Conservation Measures section of this BO. However, on March 25, 2015, the DON sent the Service a list of proposed Conservation Recommendations. The first Conservation Recommendation included the reintroduction paragraph for the extirpated species. The Service advised the DON that when the Service writes Conservation Recommendations for an action agency, these recommendations include items that the action agency is not currently doing or not currently committed to doing. Therefore, by including the reintroduction paragraph into the Conservation Recommendations, as requested by DON, the Service interprets this as DON reversing a previous commitment to allow the reintroduction of listed species on DoD land on Guam. The Service requested the DON provide clarification on this issue.

April 14, 2015. The Service and DON discussed that conservation recommendations in a biological opinion are not binding, and it is at the discretion of the action agency on their implementation. The Service and DON also discussed the reintroduction of native species language per the April 13, 2015, Service email sent to the DON. The Service requested that the language remain in this BO. The DON suggested that the Service include the reintroduction language in the introduction letter and in the baseline of this BO, as it is an action the DON will support in the future when threats are reduced. DON asked the Service for an update on the status of this BO. The Service stated that a draft BO would be available for DON's review on April 27, 2015, and that the analysis is in review at the RO.

April 16 and 17, 2015. The Service and DON exchanged emails regarding the ungulate fence conservation measure for *S. nelsonii*.

April 24, 2015. Office of the Secretary of Defense and Deputy Assistant Secretary of the Navy (Environment) met with Department of the Interior, Deputy Assistant Secretary for Fish, Wildlife, and Parts, the Deputy Director and Assistant Director for the Service, and Regional Director for the Service's Pacific Region to discuss staffing fixes and streamlining consultations. The Service and DoD agrees to develop a Memorandum of Agreement (MOA) to preserve a minimum amount of kingfisher habitat on DoD land in northern Guam.

June 4, 2015. The Service received updated information from the DON regarding the total number of acres of habitat for *S. nelsonii*, Mariana crow, Guam rail, Mariana fruit bat, and the Guam Micronesian kingfisher that would be removed as a result of the proposed project.

June 11, 2015. The Service and DON entered into an MOA to ensure that sufficient amount of suitable survival and recovery habitat for the Guam Micronesian kingfisher is conserved and managed within DoD lands in northern Guam (see Appendix C).

June 26, 2015. The Service provided the DON with the draft BO for their review.

July 6, 2015. The Service received comments on the draft BO from the DON.

July 13, 2015. The Service received comments to the draft BO entitled "Priority Issues" and "Top 5 Issues".

July 29, 2015. The Service met with DON and provided responses to DON comments received on July 6 and July 13. The agencies discussed the DON comments and Service responses to comments.

July 31, 2015. The final BO was signed and submitted to DON. The Service's Regional Office notified DON that work on the conference opinion on the newly listed species for the proposed project would start in August and be completed by November 30, 2015.

August 21, 2015. The DoD provided information on the status of the proposed project.

September 3, 2015. The Service acknowledged receipt of the DON's March 10, 2015, letter and enclosed Conference Assessment dated February 26, 2015, requesting a conference on the effects of the subject project on the following federally proposed listed species: *Bulbophyllum guamense*, *Cycas micronesica*, *Tabernaemontana rotensis*, Mariana eight-spot butterfly (*Hypolimnas octocula marianensis*), humped tree snail (*Partula gibba*), Guam tree snail (*Partula radiolata*), and fragile tree snail (*Samoana fragilis*). The Service noted that the review of incoming documents were delayed because of the Service's substantial section 7 workload. The Service also requested clarification on the term "maximum extent practicable" related to the proposed conservation measures for the listed species; re-evaluation of the effects determinations; and consideration of the on-going or recently completed surveys for the proposed listed species conducted within project footprint, including areas that would be used for training within the Naval Base Guam's Naval Munitions Site.

September 15, 2015. DON responded to the Service's letter requesting clarification on the additional surveys in the September 3, 2015 and requested formal conference on the additional species included within the Conference Assessment.

October 1 and 2, 2015. The DON provided an update on the implementation of the conservation measures per the July 31, 2015, BO on the subject action. The DON requested to reinitiate the subject consultation because of project effects to the newly listed species. The DON provided a map of locations for *B. guamense*, *T. rotensis*, *Tuberolabium guamense*, *Heritiera longipetiolata*, *Dendrobium guamense*, within the ungulate management fence at NFW, AAFB. The Service

requested the survey results, including the methods, for the newly listed plants within the action area. This information was needed to complete the status of the species in the action area and confirm the project effect determinations for the newly listed species. The DON stated that they would submit a progress report for survey in northern Guam, which should include the methods and results, to the Service. The DON and Service also discussed the information needs, the timeline for the consultation, and the effect determinations per the Service's September 3, 2015, letter.

October 2, 2015. The Service requested information on the status of *C. micronesica* on Tinian. The DON provided the information via email on the status of the JRM's fiscal year 2014 project on the *C. micronesica* in Tinian.

October 13, 2015. The DON requested that project activities for geotechnical borings proceed within areas of NWF (DON project P-715 area) and Finegayan (DON project J-016 area). The DON submitted maps of special status species within the P-715 and J-016 areas for the Service's review. Subsequent emails throughout November followed this request. It was agreed that the DON would provide a biological monitor to survey the construction preparation locations to ensure no listed species will be impacted. Biological monitors would be able to identify all listed species within the action area. If listed species are observed, DON will work with the contractor to avoid impact to the listed species. DON will provide a map depicting the final location of all vegetation clearing after construction prep is complete to document any changes from the original plan. On January 21, 2016, the DON reported that the geotechnical work was half way completed in the NWF area.

October 14, 2015. The Service sent an email to DON as a reminder of the request for the survey results for the newly listed plants within the action area. In addition, the Service stated that they did not require a BA as long as DON provided the missing information and clarification in a single adequate detailed written response to the Service's September 3, 2015, letter.

October 14, 2015. The DON sent an email to the Service with an attachment of a map that included locations of listed species within the ungulate management fence. This map also was submitted to the Service on October 1, 2015. In addition, the DON stated that the final report for the newly listed species would not be completed for another eight months because they wanted to add additional survey areas. However, the DON could submit a progress report.

October 26. 2015. The DON submitted a letter in response to the Service's letter dated September 3, 2015. The letter included confirmation on the section 7 consultation for the newly listed species; a statement that the survey maps of recently completed surveys for the NWF area were provided to the Service on October 13, 2015; a statement that the proposed action will directly impact the Mariana eight-spot butterfly, *T. rotensis*, and *H. longipetiolata*; a statement that no project impacts are anticipated for *B. guamense*, *C. micronesica*, humped tree snail, Guam tree snail, and fragile tree snail; a statement that no Marine Corps relocation-related ground training would occur in the NMS; and best management practices.

October 29, 2015. The DON and Service discussed the October 26, 2015, letter which included the statement that no project impacts are anticipated for *B. guamense*, *C. micronesica*, humped

tree snail, Guam tree snail, and fragile tree snail. The DON stated that the consultation should be formal for *B. guamense* and *C. micronesica*; and informal for, the three listed snails.

November 10, 2015. The DON sent monthly, October 2014 to August 2015, status reports of plant surveys submitted to JRM.

December 3, 2015. The Service sent an email to DON requesting DON's proposed conservation measures for the Mariana eight-spot butterfly. The DON and Service discussed re-scheduling a meeting with the butterfly researchers/experts to discuss the value to recovery and the feasibility or logistics of the conservation measures for the butterfly. Please note that a butterfly meeting was schedule in mid-November but because of a storm the majority of the partners were not able to attend.

December 15, 2015. In a letter and enclosed map, the DON included the locations of *T. guamense* and *D. guamense* within the northern Finegayan area. The DON stated field surveys to date have identified over 2, 300 *T. guamense* and two populations of approximately 100 *D. guamense* on five trees. The DON concluded that the proposed action may affect, but will not adversely affect *T. guamense* and *D. guamense*.

December 16, 2015. The DON and Service discussion focused on the December 15, 2015, letter, and conservation measures proposed for the *T. guamense*, *D. guamense*, and the Mariana eight-spot butterfly. The DON stated that potentially approximately 100-150 plants of the *T. guamense* and 1 plant of the *D. guamense* could be avoided. These plants that potentially could be avoided are located in the northern boundary of map enclosure of the December 15, 2015, DON letter to the Service. The contractor will be "encouraged to design the project to avoid these plants", however because of potential geotech and sink hole issues that are not apparent at the early stage, it is not known if some plants could be avoided until the DON is further in the design stage with the contractor. The individuals of *T. guamense* and the *D. guamense* located within the middle or center of the map will not be avoided. The Service asked the DON whether individuals of *T. guamense* and the *D. guamense* could be relocated to the proposed forest enhancement area at Finegayan. For the Mariana eight-spot butterfly, the DON proposed the butterfly's host plants would be restored within the Finegayan restoration site and the collection of eggs and larvae would be collected within the LFTRC, so experts can propagate the butterfly. In addition, the DON stated that they were expecting a final BO by February 15, 2016. The Service stated that there was not enough time to finalize the BO by February 15, 2016.

December 17, 2015. The DON sent an email to request the due date of the final consultation. In the DON's email it was noted that Terry Rabot with the Service identified the consultation end date as of November 2015.

January 11, 2016. The Service requested an update on project activities for geotechnical borings proceed within areas of NWF (DON project P-715 area) and Finegayan (DON project J-016 area). On January 21, 2016, the DON reported that the Route 3A geotechnical work is completed, and the geotechnical work within the LFTRC is currently in progress with biomonitors accompanying the geotech crew on site.

January 12, 2016. The Service requested the DON review the description of the proposed training activity at the NMS to ensure the accuracy of the proposed action. On February 1, 2016, the DON included the written changes to the training operations in the NMS by email to the Service.

January 21, 2016. The DON and Service discussed the timeline for the completion of the formal consultation. It was discussed that the survey report on the newly listed plants has not been finalized. The Service advised the DON that the formal consultation may need to be reinitiated if new information reveals effects of the action agency that may affect listed species in a manner that causes an effect to the listed species not considered in the BO. As a follow up to the December 16, 2015 meeting, the DON stated that they would not salvage *T. guamense* and *D. guamense*. The DON stated that any salvage or translocation of *T. guamense* and *D. guamense* should be included as a conservation recommendation in the final BO.

January 26, 2016. The DON and Service discussed finalization of the BO and the agreed the target due date as the end of March 2016.

January 27, 2016. The DON requested via email the opportunity to review the draft BO and suggested the Service deliver the draft BO by March 24, 2016. DON proposed to provide comments to the Service by March 29, 2016 and requested the Service sign the BO by March 31, 2016.

January 28, 2016. The Service responded to DON's request to provide a draft BO, stating that two days to review DON's comments sign the BO was insufficient time to finalize the BO.

January 28, 2016. The DON and Service discussed the language to describe a qualified biologist per implementation of conservation measures in the BO; the need to update Mariana fruit bat status of species in BO per new observations of a bat colony on AAFB; status of the finalization 5,324 acres per the kingfisher MOA; status of the relocation of the ungulate management fence at NWF; review of the Consultation History section of the BO; removal of the information about the Mariana swiftlet from the Environmental Baseline section; and status of the informal consultation for the subject action. The DON stated that any salvage or translocation of *T. guamense* and *D. guamense* should be included as a conservation recommendation in the final BO.

January 31, 2016. The DON asked how much time would be needed to review DON's comments and finalize the BO. On February 3, 2016, the Service stated that they would provide a signed BO within five business days after receiving DON's comments on the draft BO.

February 4, 2016. The DON sent a letter to confirm the changes in the timeline for the completing the BO. The DON asked the Service to provide a draft BO my mid-March, followed by a review period, with an anticipated final BO due in mid-April. The letter included new information on identification of over 5,000 *T. guamense* and over 300 *D. guamense* at Finegayan.

February 4, 2016. Email correspondence was exchange from February 4 to12, between the DON and Service which included clarification of the number of individuals of *B. guamense*, *T. guamense* and *D. guamense* that are within the action area and the number of individuals that

would be removed as a result of the proposed project activities and other project details; and a reference for the information on environmental baseline conditions for *S. nelsonii.*

February 5, 2016. The Service acknowledged that sufficient information to reinitiate the subject formal consultation was received from the DON. The Service stated that a draft BO would be completed on March 25, 2016 and a final BO would be completed by April 15, 2016.

February 17, 2016. The DON and Service discussed the potential need to reanalyze the project impacts to the Mariana fruit bat because of the change in the status of the species within the action area. The DON would submit information to the Service on the status of the Mariana fruit bat within the action area and any observations on movement of individual bats to and from the colony. The Service also asked for confirmation that project impacts to the endangered *Psychotria malaspinae* would be avoided. The DON confirmed there would be no effect to *P. malaspinae.*

February 17, 2016. The draft Consultation History section was sent to DON's for their review. On March 1, 2016, the DON provided comments on the draft Consultation History section.

February 19, 2016. The Service sent an email to DON requesting that DON include as a conservation measure the salvage and relocation of the listed orchids, specifically *T. guamense* that cannot be avoided in the course of construction.

February 22, 2016. DON provides the Service with the monthly progress report for January and February 2016 for the monitoring of Mariana fruit bats on Andersen Air Force Base (AAFB), Guam. The progress report collates the first sightings of fruit bats on AAFB in the Habitat Management Unit area (November to December 2015) with the results of bat surveys in the HMU in January and February 2016. The report presents the findings of field surveys conducted by the principle investigator, Tammy Mildenstein.

February 24, 2016. The Service requested information on how many individuals of *T. rotensis* would be removed/loss as a result of the proposed action. On March 2, 2016, the DON determined the number of *T. rotensis* individuals loss or removed as a result of the proposed action.

February 24, 2016. In a letter, the DON requested reinitiation of this consultation because of the increase in the number of Mariana fruit bats within the action area. The bats within HMU represents a possible breeding colony on Guam. The DON also requested that the amount or extent of take for Mariana fruit bats be increased to reflect the change in the current population of Mariana fruit bats. The take would continue to be in the form of repeated harassment leading to injury from loud aircraft noise, operation of the LFTRC, construction noise, and other human disturbance resulting from the proposed action. The DON also sent via email a document entitled *Memorandum for File, Subject: Pre-Construction High Value Tree (HVT) Surveys of J-001B Utilities and Site Improvements Phase I, Naval Base Guam.*

March 3, 2016. The Service asked DON to provide the report on the surveys for the Mariana eight-spot butterfly that indicated this species occurs at the Mangilao golf course and Fadian Cove as stated in the DON's conference assessment.

March 10, 2016. The DON sent an email to the Service stating that *Tuberolabium guamense* and *Dendrobium guamense* would be salvaged within the action area to the maximum extent practicable. The email provided details on the qualified biologist performing this measure.

March 14, 2016. The Service and DON discussed project activities that would adversely affect the Mariana eight-spot butterfly and *Tuberolabium guamense*. Clarification on the impacted area for the butterfly within the proposed live-fire range complex and the conservation measures for these two listed species were discussed. The Service stated their preliminary analysis on the project impacts of the DON's action indicated very serious deleterious consequences for *T. guamense* and Mariana eight-spot butterfly. The Service indicated that the seriousness of the concern could likely push back finalization of the draft BO. The Service asked if there was any way DON could avoid taking approximately 5,000 *T. guamense* plants from one project site in the Finegayan area. The Service also indicated that one firing range, as currently planned, would take one of nine known concentrations of Mariana eight-spot butterflies, and asked if the range could be altered to avoid the take. DON determined it would seek clarification and evaluate possible options following the phone call. The DON asked what percentage of the 5,000 *T. guamense* plants could be taken to avoid deleterious and serious findings in the analysis. The Service responded it would look into whether or not it would be able provide that information.

March 21, 2016. DON indicated that the construction plans for the Finegayan area were not finalized, and could not be specifically altered at the current time because the bids were not completed and geologic analyses of the suitability of the site were not completed. DON maintained that construction would avoid orchids to "maximum extent practicable" and would re-insert the conservation measure to relocate individuals that could not be avoided. The Service made clear that the success of transplantation was unknown and had to be considered as such in analyses, and offered that the effects would likely still be severe unless more plants could be avoided. The DON suggested that the host plants of the Mariana eight-spot butterfly might not be in the impact zone of the live-fire training range, and offered to provide some more detailed maps to better indicate the location of the butterflies relative to the range.

March 22, 2016. The DON sent additional information on the number of individuals of *Tuberolabium guamense* that occur within DoD land on Guam.

March 24, 2016. The DON sent a report on the rare plant surveys conducted within the action area by the University of Guam.

March 31, 2016. The DON reviewed and updated the conservation measures for the proposed project.

B. DESCRIPTION OF THE PROPOSED ACTION

The DON proposes to relocate USMC personnel from Okinawa, Japan to Guam; construct and operate a main cantonment area, including family housing; and construct and operate a live-fire training range complex (LFTRC); and conduct training activities on Guam. Project activities will occur on land administered by the DoD and the Government of Guam (for road and bridge work). The proposed action also includes activities that were initially proposed in the 2010 DON

BO, and that will now be covered in this Biological Opinion. To be consistent with the BA (DON 2014a) and the Draft SEIS (2014b), these actions will be called "carry over" actions. The project description is based on information in the BA (DON 2014a), the Draft SEIS (DON 2014b), addendum to the BA (DON 2015b), and the DON's review of the Draft Biological Opinion (see Consultation History).

The proposed action includes the following components:

- Relocation of approximately 5,000 USMC personnel and 1,300 dependents from Japan to Guam
- Construction of the main cantonment within 1,213 acres at Finegayan, AAFB
- Construction of housing within 510 acres at AAFB
- Utilities and site improvement activities within DON-administered lands
- Road and bridge development and/or improvement within DON-administered lands and Government of Guam lands
- Construction and operation of the LFTRC at NWF, AAFB
- Establishment of a SDZ within NWF and the GNWR
- Development and operation of a hand grenade range at Andersen South
- Air craft training activities within the NMS and adjacent areas
- Conservation measures for federally listed species

Relocation of U.S. Marines and Population Growth on Guam

In furtherance of an agreement with the Government of Japan, the DON plans to relocate 5,000 USMC personnel and 1,300 dependents from Okinawa to Guam. Based on the most recent population estimate for Guam, which is approximately 161,000 residents (CIA 2015), the relocation is estimated to temporarily increase Guam's population by approximately 10,000 (DON 2014b, p. ES-4) or 6.2 percent by 2021. This number will decrease to about 7,400 additional residents after construction is completed in 2028 (DON 2014b, p. ES-4) or a 4.6 percent overall increase.

Probable Sources of Labor Supply

An estimated maximum number of 1,227 workers from Guam would work on construction projects related to the proposed project. A maximum of 3,227 workers from off-island would work on construction projects related to the proposed project. It is anticipated that the majority of off-island construction workers would be H-2B workers from the Philippines and other Pacific Islands. During the later years of construction (2025-2026), it is anticipated that more workers from Guam than from off-island would work on construction projects related to the proposed project.

Construction

The DON proposes over 130 separate construction projects on Guam (DON 2014a, Appendix A) to occur within a time period of thirteen years. The construction projects include clearing, grubbing, earthwork (such as digging, trenching, drilling, boring and/or cut and fill), processing

and stockpiling of green waste, erosion and sediment control, roadways, sidewalks, curbs and gutters, traffic signs, temporary construction fence, perimeter / security fence, ungulate fence, landscaping and other site improvements. The construction projects also require removal of vegetation, stripping limestone rock, and removal and stockpiling of reusable topsoil. Typical equipment used would include heavy haul trucks, excavators, cranes, concrete trucks, cranes, backhoes, graders, and pick-up trucks. Construction activity would be temporary and localized within existing noise contours that range from 60 to 85 dB average day-night sound level (ADNL) (DON 2014a, p. 64; see Operation of LFTRC section below for definition of ADNL). The use of heavy equipment can reach noise levels of 96 dB (USFWS 2006a, p. 15). No blasting or use of dynamite will occur as part of the proposed project. The construction activities are summarized below and details are provided in the BA (DON 2014a, pp. 9-18).

Main Cantonment

The proposed main cantonment development includes base operations and support facilities constructed within 1,213 ac at Finegayan, AAFB (DON 2014a; p. 2, 14-17, DON 2015b). An approximately 27,900-ft (8,500-m) long security fence will be constructed around the main cantonment perimeter. The main cantonment and support facilities are divided into the categories listed below, followed by examples of buildings/facilities for each category.

- Command core - Marine expeditionary brigade headquarters and command buildings
- Unit operations – 3rd Marine expeditionary brigade command element, 4th Marines, ground combat element infantry battalion 1 and 2, artillery battery, combat logistics battalion, 9th engineer support battalion and explosive ordnance disposal
- Base operations – base administration, fire station, public works, vehicle fueling, base auto shop, kennel, corrosion prevention and control, security
- Bachelor enlisted quarters and bachelor officer quarters
- Community support – dining facility, fitness center, recreation areas, education center, auditorium/theater, branch exchange, bank/credit union, food court/amusement center, medical/dental clinic, post office
- Training – battle training center, individual combat skills course

Family Housing

The proposed family housing will be located at currently existing family housing (510 acres of developed land) on AAFB. Family housing includes residences for accompanied permanent USMC personnel and their dependents and support and recreational facilities. Unaccompanied USMC personnel would stay at the main cantonment during their shorter-term (approximately 6 months) assignment to Guam. The proposed housing density at AAFB is 5.5 units per acre. The family housing area would be accessed by the existing family housing gate (the Santa Rosa Gate) at the northern end of Route 15, or from the AAFB Main Gate off Route 9. The existing family housing would be demolished and 912 family housing units would be constructed as replacements for the existing AAFB housing in addition to the 535 family housing units required for USMC families. All of the 1,447 family housing units would be integrated into one large housing pool where all eligible personnel and families would live.

Expansion of existing community support facilities, such as the child development center, youth center, and temporary lodging facility may be required. New facility construction may include a temporary lodging facility, a community center, and a family support center.

Potable Water
Water for the family housing area would be provided by the current system, which would be modified to reroute the system along the new road alignments for the proposed family housing. There will be a connection from the AAFB well field water storage tank to the AAFB water system to provide water to the proposed family housing area. The new potable water distribution pipes would be installed underground at least 3-ft (0.9-m) deep. The width of the trench to install the pipes would be about 1.5 to 4 ft (0.46 to 1.2 m).

Wastewater Collection
The family housing wastewater collection system would include a network of gravity mains, manholes, two wastewater pump stations, force mains and refurbishment of existing wastewater pump stations. The family housing wastewater collection system would use the existing connection to the Guam Water Authority's (GWA) wastewater collection system. Existing wastewater pump stations would be demolished as part of the proposed project. Wastewater would be conveyed to the Northern District Wastewater Treatment Plant for treatment and disposal.

Power
The existing AAFB main substation would have adequate capacity to serve the family housing, including the redeveloped housing units, new common facilities, and expanded common facilities. The distribution system would be rebuilt, enhanced, and reconfigured to accommodate the housing layout.

Solid Waste
Family housing areas would continue to have their solid waste handled as currently done for the existing AAFB housing area (Layon landfill).

Utilities and Site Improvements

The proposed action includes the development of on-site utilities, access roads, and related off-site infrastructure to support the main cantonment, family housing and LFTRC.

Grading and Earthwork
The utility and site improvement work includes major earth moving (mass grading) and limited fine grading along the roadway corridors and drainage systems. The cut and fill quantities associated with this mass grading would require approximately 5,300,000 cubic meters of structural fill material. The cut and fill quantities also assume a 2-ft (0.6-m) deep typical road pavement section including compacted base and pavement surfacing. The cut and fill quantities are based on the assumption that native material excavated on site is suitable for reuse as fill material. If soil testing and/or geotechnical recommendations indicate otherwise changes in grading or importation of material may be required. Contractors are required to obtain aggregate/soil from contractors/vendors who have local permits. Imported sand and other quarried products from abroad are subject to inspection by the Guam Department of Agriculture

and require an importation permit. All sand and aggregate material imported must be accompanied by official records indicating chemical composition, pest-free certification, treatment certificate, and certificate of origin.

Although the Draft SEIS estimated that the amount of cut exceeds the amount of fill required, the DON contract does not prohibit quarry material from off-island. For example, any grading or other earthwork required during facility construction at any of the alternative sites would be implemented to balance cut and fill on-site to the extent possible. If off-site fill material were needed, it would be obtained from a permitted source. In addition, if a contractor needs fill material the excess cut from other DoD projects would be available for no additional cost as opposed to paying for fill material from a quarry (DON 2015b).

Best management practices for utilities includes the Comprehensive Waste Management Plan, August 2010 (DON 2010a or any applicable update), and the Integrated Solid Waste Management Plan for DoD Bases, Guam, February 20, 2013 (DON 2013a). Additional contractor requirements are as follows: process green waste on-site for reuse (goal of 100 percent) during construction; meet 50 percent diversion rate goal for construction/demolition debris through reuse (including such actions as concrete crushing and reuse as base material and grinding and reuse of asphaltic concrete from roads); and meet a goal of 50 percent diversion rate from disposal for project non-construction/demolition solid waste (not directly generated from materials used for erecting structures).

Based on the FAR 52.236-7, PERMITS AND RESPONSIBILITIES (DON 1991), the contractor shall, without additional expense to the government, be responsible for obtaining any necessary licenses and permits, and for complying with any Federal, State, and municipal laws, codes, and regulations applicable to the performance of the work. The contractor shall also be responsible for all damages to persons or property that occurs as a result of the contractor's fault or negligence. The contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the entire work, except for any completed unit of work which may have been accepted under the contract.

Reuse and Recycling Facility
Green waste processing and construction and demolition debris generated during construction will be handled by contractors at designated laydown areas. Contractors will be required to process the generated green waste as part of their assigned contract requiring 100 percent diversion of the green waste into mulch (trees and stumps) and compost (leaves and grass), and 60 percent minimum diversion of construction and demolition debris waste. The DON subject matter experts will review the contractor's green waste processing and composting facility operations plan to ensure that it meets industry and regulatory standards. The contractor will be responsible for obtaining the solid waste facility permit issued by Guam Environmental Protection Agency (GEPA) prior to commencing activities.

The construction and demolition debris and green wastes that cannot be recycled or reused, as well as wastes that are prohibited at Layon Landfill would be disposed at the Naval Base Guam Landfill, subject to ongoing discussions between the U.S. Environmental Protection Agency (USEPA), GEPA, and DON, and permitted private hardfill facilities (DON 2015b).

Electrical Substation
A main substation equipped with two 15-megavolt ampere, 34.5 kV-13.8 kV transformers will be constructed in the main cantonment area, south of the main gate. Provisions will be made in the substation for primary line connections to the planned 34.5-kV underground line from the Harmon Substation and to the planned 34.5-kV line from AAFB.

Water Distribution
A new transmission main, to be installed by the well field project, will convey water from the well field storage tank at AAFB to the boundary of the main cantonment area near the commercial/tactical vehicle gate. The DON proposes to construct a water pipeline from Route 3A near the commercial/tactical vehicle gate to the new two million gallon ground level water storage tank on Finegayan. The existing mains between some of the existing water wells on Finegayan will be demolished and realigned to the proposed roadways. The existing distribution mains servicing the abandoned Building 200 also will be removed. In the short term, the existing Finegayan water wells will provide the USMC water distribution system with water. The long-term plan will provide the USMC water distribution system with water from both the existing Finegayan wells and the well fields system.

Sanitary Sewer
The existing DoD wastewater collection system within the main cantonment area at the Finegayan site consists of a trunk sewer serving Building 200 and connected to the GWA wastewater collection system through a GWA interceptor sewer along Route 3. Wastewater is conveyed to the Northern District Wastewater Treatment Plant. Capacity evaluations of the existing collection system indicate the GWA interceptor sewer has adequate capacity for the project. The grading for the main cantonment area generally slopes downhill from north to south. A connection to the existing GWA interceptor sewer main along Route 3 is included.

Live-fire training range complex

The proposed LFTRC development area at AAFB NWF will require construction of the individual ranges, range support building, range towers, range access roads, and a perimeter fence (all within federally-controlled land at NWF), extending an ungulate fence (see Conservation Measures section) and the establishment of a SDZ within the NWF and the GNWR. The LFTRC would require construction of electrical, telecommunication, wastewater and water lines and/or facilities configured to operate with the existing utility infrastructure of AAFB NWF (DON 2014a, pp. 18-22).

The proposed LFTRC would include five ranges and repairs to Route 3A. The individual ranges are described in more detail below (DON 2014b, p. 2-7).

Known Distance (KD) *Rifle Range*: The proposed KD Rifle Range would have 50 firing points for 5.56-millimeter (mm) weapons. The range would be 534 ft (163 m or 178 yards) wide and 1500 ft (457 m or 500 yards) from the farthest firing line to the target line. The target line would be flush with the ground, and there would be level ground from the 200 yard (183 m) firing line to the target line. The range would include a 25-foot (8-m) tall impact berm behind the target line. The range footprint would encompass approximately 18.5 ac (7.5 hectare [ha]).

KD Pistol Range: The KD Pistol Range would provide 25 firing points for training with 9-mm and 0.45-caliber (cal) weapons. The range would be 123 ft (37.5 m or 41 yards) wide by 150 ft (46 m or 50 yards) long with level ground from the firing line to the target line. The range would include a 12-ft (4-m) tall impact berm behind the target line and 12-ft (4-m) lateral berms. The range footprint would encompass approximately 0.4 ac (0.2 ha).

Non-standard Small Arms Range: The Non-standard Small Arms Range would provide 25 firing points, and be used for training with 5.56-mm weapons. The range would be 204 ft (62.5 m or 68 yards) wide by 328 ft (100 m or 109.4 yards) long with level ground from the 91 m firing line to the target line. There would be a 16-ft (5 m) tall impact berm behind the target line, and 16-ft (5-m) lateral berms. The range footprint would encompass approximately 1.5 ac (0.6 ha).

Modified Record of Fire Range (MRF): The proposed MRF Range would have 16 firing points for use by 5.56-mm weapons. This live-fire range area would be 525 ft (160 m or 175 yards) wide by 657 ft (200 m or 219 yards) in length with a 25-ft (8-m) tall impact berm at the far end of the range. The range footprint would encompass approximately 7.9 ac (3.2 ha).

Multi-purpose Machine Gun (MPMG) *Range*: The proposed MPMG Range would have eight stationary firing lanes to support training with 5.56-mm, 7.62-mm, and 0.50-cal weapons, as well as 40-mm inert training rounds (i.e., non-explosive). The range would be 525 ft (160 m or 175 yards) wide at the firing line, expanding to 1,050 ft (320 m or 350 yards) wide at the far end of the range. The range would be 3,281 ft (1,000 m or 1093.6 yards) long and would include a 25 ft (8 m) tall impact berm at the far end of the range. The range footprint would encompass approximately 59 ac (24 ha).

Except for the MPMG Range, the range footprints would be entirely cleared of vegetation and the range would be designed with berms to contain expended rounds of ammunition within the range footprint. The MPMG Range would include more uneven terrain and with some vegetation. The purpose of the MPMG Range is to simulate a more natural environment. Vegetation on the range would be designed using the Guam Landscaping Guidelines (DON 2011) and use appropriate or non-invasive species in order to reduce potential impacts associated with non-native vegetation.

The proposed LFTRC also would include three range observation towers, a target storage and maintenance shed, a ready issue ammunition magazine, covered bleachers, portable toilets, perimeter fencing, safety signage, parking, and lighting. Lighting will be designed to meet minimum safety, sustainable, antiterrorism, and force protection requirements. "Night-adapted lights" will be installed in the briefing and bleacher areas at NWF. Night-adapted lights include bulbs in red or other spectrums that allow a person's eyes to remain adapted to low light or night conditions while still providing enough light for work and safety. Illumination of the coastline or beach will be kept to an absolute minimum including the shielding of lights and directing lighting away from the forest or other wildlife habitat (see Conservation Measures section below).

The location and siting of firebreaks will be addressed in the fire management plan (see Conservation Measures section). The fire management plan, which is a component of the Range

Management Plan, will address issues as it relates to the potential for a fire to start on the range and how to control any fires.

Construction of LFTRC

Development of the LFTRC is anticipated to occur in two phases that would construct the smaller ranges and repair/improve Route 3A under one phase and construct the MPMG Range under the second phase. Approximately 256 acres would be cleared as a result of the construction of the LFTRC (DON 2014a, p. 19). Proposed construction timelines are subject to availability of funding but are proposed as: 1) The dates for the KD ranges are March 2016 for the construction award, August 2019 for the completed construction, and start of range operations in February 2020, and 2) The dates for the MPMG Range are January 2021 for the construction award, January 2024 for the completed construction, and range operation starting in December 2024.

Grading requirements for construction of the ranges and associated infrastructure would include 2,047,295 yd^3 (1,565,270 m^3) of cut and 1,932,392 yd^3 (1,477,420 m^3) of fill, resulting in a net of 114,903 yd^3 (87,850 m^3) of cut (DON 2015b). However, any grading and other earthwork required during facility construction at any of the ranges would be implemented to balance cut and fill on-site to the extent possible. If off-site fill material were needed, it would be obtained from a permitted source.

Operation of LFTRC

Range utilization would depend on the number of personnel required to complete annual individual training events, the duration of each event, and the training capacity of each range. However, the proposed live-fire operations at the LFTRC would occur between 7:00 a.m. and 7:00 p.m. for up to 39 weeks per year, and night operations (estimated to occur 2 nights per week over 39 weeks per year) would occur between 7:00 p.m. and 10:00 p.m. or 6:00 a.m. and 7:00 a.m. The estimated annual ammunition usage of the LFTRC by USMC and non-USMC personnel is 6,719,190 rounds (DON 2014b, p. 2-9) (Table 1).

Table 1. The estimated annual ammunition usage of the LFTRC (DON 2014b, p. 2-9).

Range	*Weapon*	*Ammunition Type*	*Estimated Ammunition Usage*		
			Day [1]	*Night* [1]	*Total*
Marine Corps					
KD Rifle Range	M16/M4	5.56-mm	1,533,300	322,800	1,856,100
	M249 SAW	5.56-mm	59,200	39,664	98,864
KD Pistol Range	M9	9-mm	324,956	19,328	344,464
Non-standard Small Arms Range	M16/M4	5.56-mm	569,356	403,500	972,856
	M249 SAW	5.56-mm	152,736	34,900	187,636
MRF Range	M16/M4	5.56-mm	304,920	62,820	367,740
	M249 SAW	5.56-mm	59,200	17,760	76,960
MPMG Range	M249 SAW	5.56-mm	377,104	0	377,104
	M40/M110	7.62-mm	13,824	4,104	17,928
	M240	7.62-mm	576,716	141,336	718,052
	M107	0.50-cal	3,520	0	3,520
	M2	0.50-cal	190,756	6,180	196,936
	MK19	40-mm inert	84,480	8,448	92,928
	M-203/ M-32 Grenade Launcher	40-mm inert	24,940	2,580	27,520
Marine Corps Total Estimated Use =			4,275,008	1,063,420	5,338,608
Joint Use (non-Marine Corps) Total Estimated Joint Use =			1,104,466	276,116	1,380,582
GRAND TOTAL (MARINE CORPS AND JOINT USE) =			**5,379,474**	**1,339,536**	**6,719,190**

Legend: SAW = Squad Automatic Weapon.

Notes: [1]"Day" operations would occur between 7:00 a.m. and 7:00 p.m. "Night" operations (estimated to occur two nights per week) would potentially occur between 7:00 p.m. and 10:00 p.m. or 6:00 a.m. and 6:59 a.m. Night firing training requirements need to be met during hours of darkness, dusk until dawn, and this timeframe differs from "acoustic" night (10 p.m. to 7 a.m.) used in noise modeling. Of the 1,063,000 rounds expected during darkness, only 326,000 rounds or 7% of the total number of rounds would occur during "acoustic" night, and no training is planned to occur between the hours of 10:00 p.m. and 6:00 a.m.

The noise levels at LFTRC are estimated at weighted day-night average sound levels (ADNL) within the immediate and adjacent areas and would range from 55 ADNL to greater than 85 ADNL, depending on the zone (area) (DON 2014a, p. 68). The ADNL is a metric that cannot be measured directly. Rather, it is calculated as the average sound level in decibels with a 10 dB penalty added to the night-time levels (10 p.m. to 7 a.m.). This penalty accounts for the fact that noises at night sound louder because there are usually fewer noises occurring at night so generally night-time noises are more noticeable. The day-night sound level (DNL) noise metric may be further defined, as appropriate, with a specific, designated time period (e.g., annual average day DNL, average busy month DNL). Noise levels due to .50 caliber or less small arms weapons use the average-weighted scale and are expressed as dB average-weighted DNL (ADNL).

The noise disturbance from the training will be impulse noise with very intense sounds of short duration (*e.g.*, the discharge of a weapon). Firing noise from single shots merged in bursts, machine gun burst, and concurrent firing of multiple weapons would result in short periods of intense firing followed by periods of silence. Live-fire operations may occur for hours at a time, for 5 days a week, or not occur for multiple weeks in a row. The DON provided the Service with peak noise levels for the MPMG Range using a formula to calculate peak noise levels at a specified distance from the source. Because the peak noise calculation did not account for sound attenuation from the directional nature of the noise generated by the muzzle blast, terrain,

ambient noise, vegetation, temperature, humidity, and other factors, the Service developed a model to estimate peak noise from the LFTRC (USFWS 2015a).

Surface Danger Zone

The DON proposes to establish a SDZ within the NWF and the GNWR (Figure 1). The SDZ would delineate areas that fired ammunition fragments or ricochet may land, forming the outermost limit of the LFTRC. The DoD standard for risk acceptance on ranges is a 99.9999% level of containment, which means the probability of munitions (for inert ordnance) or a hazardous fragment (for live ordnance) escaping the SDZ is one in a million. The SDZ projects north and outward over the GNWR-administered fee simple land and submerged lands. The DON would demarcate the SDZ beyond the shoreline through navigation map updates to alert maritime traffic of the potential hazard. For the land based perimeter of the SDZ, perimeter access roads (KD and MPMG), perimeter fencing and/or signage would indicate its boundaries for personnel and public safety. Approximately 3,701 acres (1,498 ha) acres of lands and submerged lands are required to support the SDZ. This includes approximately 142 acres (57 ha) of the Ritidian Point Unit (fee simple land) of the GNWR and 3,059 acres (1,238 ha) of the submerged lands of the Philippine Sea. No critical habitat within the GNWR would be cleared as a result of the proposed project.

Prior to operation of the LFTRC, the SDZ would be surveyed visually from observation towers to ensure the area is cleared of people. Because the gate to the GNWR is locked outside of the hours of operation, the potential for incursion into the SDZ will be limited within the fee simple land on the GNWR. However, when operation of the LFTRC is planned, the USMC would deploy USMC personnel to put up SDZ signage on trails and the beach at either end. If there are indications that people are in the area, a patrol would be deployed to ensure safety.

Although most of the SDZ area can be seen with binoculars from the observation towers at Ritidian Point at NWF, ground patrols within the GNWR are to ensure that the area under the surface danger zone is cleared of people prior to the operations of the LFTRC. Surveys, as described below, would be conducted on the nesting beach prior to the operations of the LFTRC, which will operate daily up to 39 weeks per year. The purpose of the access is to ensure the water portion of the SDZ is clear of people. The Range Safety Specialist (RSS) would conduct a ground survey of three locations (Figure 1); however may only access one or two of these locations to clear the water portion of the SDZ. The RSS will access the location by using an all-terrain vehicle (ATV) (2 or 4 passenger Gator-type vehicle). The RSS will get out of the ATV and move to an area where the water portion of the SDZ can be seen (not on the beach). The RSS will use a pair of binoculars to clear the water portion of the SDZ. The RSS will walk back to the ATV and drive out the same trail taken to get to the access locations. Once the SDZ has been cleared, the RSS would notify Range Control and depart the area. The ground survey would last approximately 20 minutes.

As part of the RSS training package, personnel would be directed to not interact with sea turtles and report all sightings to the Service and coordinate with the GNWR on nesting surveys at the Refuge (see Conservation Measures).

Hand Grenade Range

In addition to the small arms training ranges collocated within the LFTRC, the proposed project also includes a development area for a separate HG Range at Andersen South. The proposed HG Range would include an approximately 0.9 ac-area developed as a hand grenade training complex for the M67 fragmentation grenade and will be connected to existing utility infrastructure where available. The following features would be developed within the hazard zone: a holding shelter for four persons, four throwing positions with grenade sumps, a range observation tower with ballistic glass, and a grenade "dudded" impact area. A grenade house would be collocated with the grenade throwing pits. There also will be a concrete munitions storage (i.e., magazine) surrounded on three sides by earthen berms for the temporary storage of hand grenades during training events.

In addition to the live-fire area, there would be a 1.0-ac non-live-fire training area developed adjacent to the range and outside of the SDZ. The training area would consist of a demonstration area with bleachers, an open practice throwing field with various targets and throwing positions, portable toilets, and a parking area. Inert practice grenades would be used at this training area to provide familiarization training prior to proceeding onto the live-fire area of the range.

Information and Communications

The proposed Information Technology/Communications (IT/Comm) development area would require inter-base connections between the proposed USMC main cantonment area, and other existing bases, the proposed LFTRC, and DON's 2010 Record of Decision-covered training facilities at Andersen South (DON 2010b). These hardwired connections would consist of conduits buried approximately 3-ft (0.9-m) deep. Off-site conduits would be encased in concrete and would have lockable manholes for security. Because redundant off-island communication paths are needed, an additional connection to the Tata Communications Cable Termination Facility (in Piti) from AAFB may be required. Off-site conduits would follow existing roads and rights-of-way between the facilities.

AAFB Well Field and Associated Water System

Increased water supply for the main cantonment area would come from the proposed AAFB well field, refurbished wells, and DON's existing water system. Based on conservative estimates, it is anticipated that to locate one well of sufficient yield to support production approximately three test wells would be required. During testing, only those wells with good water quality and capacity will be identified as production well sites. Test wells deemed unsuitable will be filled and capped and left in place, restored or converted to monitoring wells for management of the Northern Guam Lens Aquifer.

The development area would accommodate the construction of the approximately 22 test wells, 11 production wells, and associated equipment. The actual footprint of the final production wells and the access roads to each is not known at this time, but it would occur within the well field limits as shown (Figure 2).

During the design phase, the design contractor will conduct site investigations and drill test wells, determine locations of the wells, and design the entire water production system (wells, feeders, and storage tank). During the construction phase, the construction contractor will convert the test wells into production wells based on the locations identified in the design document and construct the water production system per the design specifications. Prior to start of work, efforts will be made by the design contractor to minimize disturbance to the limestone forest by inspecting the area with a DON biologist and identifying "already disturbed areas". In addition, the following actions would be implemented.

- Where disturbed areas cannot be identified, for each well location, a 14-ft (4.3-m) path will be created for the drill rig, trucks/vehicles and other equipment to get to the test well locations.

- An approximately a 100 ft x 100 ft (or 0.23 ac) work area will be required to set up the equipment at each test well location.

- For each test well, an 8 in. to 12 in. borehole will be drilled to a depth of approximately 500 ft to 600 ft below ground surface. A submersible pump will be placed at the bottom of the well, and a pump test and water sampling conducted. Based on the results of the pump test and water sampling, the well will either be abandoned or identified as a potential production well. For test wells identified as a potential production well, GIS survey coordinates will be taken and a stake placed at the test well site.

- A production well consists of well casing (approximately 10 to 12 in. diameter), screen, gravel pack, submersible well pump, pump motor housing, and surface/borehole seal. At each well station the following will be provided: well housing, discharge piping, and flow meter. Each well head will have electrical lines, water transmission pipes, and feeders to each well. The estimated disturbance area during construction is 100 ft x 100 ft (.23 ac).

- Locations of the water transmission and feeder lines will follow already disturbed areas made during test well drilling (path made by the drill rig/vehicles/equipment). A 20 ft to 30 ft wide strip will be required for construction of the pipelines, and manholes, valves, bends, anchor blocks, etc. as well as backfill material. The main transmission lines ranging from 8 in. to 16 in. will connect the well field storage tank facility to feeder lines. The individual well feeder lines, approximately 6 in. will connect the wells to the main transmission lines.

- In the well field storage tank facility area, there will be a booster pump, water treatment, storage tank, electrical room and central emergency backup generator and fuel storage tank. In addition to the 14-ft (4.3-m) path for cranes/vehicles/equipment, an approximately 550 ft x 650 ft area (8.2 ac) will be disturbed during construction of the water storage tank and associated facilities.

- Unless cuttings or excavation materials are deemed contaminated or unacceptable as fill material, cuttings will be placed back into a borehole or trench. Unacceptable fill material or excess cuttings/excavation material will be removed from the site.

- When 68 ac (75 percent of the disturbance area) is reached, the construction contractor will stop work and re-evaluate to determine if 90 ac will be exceeded.

The new potable water production wells would feed a new well field collection tank, pump and water treatment facility (chlorination and fluoridation), all proposed within AAFB. The main cantonment area would be provided with a new ground level water storage tank supplied by the new well field storage tank.

Project Activities Carried Over from the DON Action addressed in the 2010 DON BO

Andersen Air Force Base Operations

Currently, as of March 2015, the air combat element beddown facilities, air embarkation facilities, and associated buildings, a new north gate and access road with associated facilities are being constructed at AAFB.

There are two airfields on AAFB, the AAFB airfield with its north ramp and the south ramp runways. The facilities constructed at AAFB north and south ramps will be used by 12 permanently stationed MV-22 helicopters and will accommodate the loading of additional transient aircraft listed in Table 2. These aircraft will be used to conduct training and operational flights (sorties) including the following components: field carrier landing practice, familiarization-instrument, Marine air ground task force, tactical air operations center, and routine operations will occur in association with the air mobility campus and the air combat element. A training event consists of one aircraft performing a take-off, a training evolution, and a landing. These training operations will occur on airfields in current use by similar aircraft (Table 3) such as those addressed in the MITT Biological Opinion (USFWS 2015b, 66 pp.).

Table 2. Proposed aircraft loading (DON 2010b, vol 2, p. 2-91).

Element	*Number*	*Type*
Permanent stationed: Rotary wing	12	PCS (12) MV-22 (Assault Transport)
Fixed wing	12	F/A-18
Transients: Rotary wing	12	MV-22 Transport (Osprey)
	3	UH-1 Multipurpose Utility (Huey)
	6	AH-1 Attack (Super Cobra)
	4	CH53E
Fixed wing	2	KC-130
	24	F/A-18
	4-6	F-4 (visiting Allied Forces)

Table 3. Anticipated total flight operations at Andersen Air Force Base resulting from previous projects with the addition of the proposed action (Czech and Kester 2008).

Aircraft Type	Anticipated Total Aircraft Operations per Year Andersen Air Force Base			
	Previously Addressed	DON Project	Total	% Increase
Helicopter	19,029	19,489	38,518	102%
Jet/Propeller	25,697	6,424	32,121	25%

The new air combat element facilities will be used for aircraft operations, maintenance of MV-22 tilt rotor aircraft, and training and support functions. The air combat element facilities also will be used for USMC air control group training. The USMC air control group training involves coordination of air command, control, and defense units and the tactical air operations center. Training entails the operation of air traffic control radar and radio frequency emitters and facilities consisting of shelters, a portable tower, and electrical power sources. Tactical air operations center training involves the establishment and dismantling of these facilities within a 96-hour period. Training includes use of various emitters and sensors which need to be de-conflicted with other electronic equipment operating in the area. To minimize the constraints it puts on airspace availability, radar equipment, which generates strong electromagnetic radiation fields, will be operated for no more than one hour at a time. The air combat element beddown facilities will operate 24 hours per day and 7 days per week. Staffing levels will be contingent on surge and operational requirements of the air combat element facilities. Traffic will include government-owned vehicles, personal-owned vehicles, and shuttle buses from the proposed main cantonment area.

Approximately 1,000 annual field carrier landing practice and 79 annual familiarization-instrument flight events are proposed for Andersen Main Base. Field carrier landing practice operations entail one or more aircraft flying at a low altitude in almost circular patterns and involves landing on a simulated aircraft carrier during the day and, using night-vision goggles, at night. Familiarization-instrument training, including autorotation and simulated engine-out approaches will occur on the improved airfields with the support of aircraft rescue and firefighting facilities.

Rotary-wing aircraft operations will occur at the AAFB airfields and in various proposed training areas on Guam. Fixed-wing aircraft operations will occur only in the immediate airfield environment of AAFB. Aircraft will then leave this area to conduct activities within established training areas of the MITT or other locations as described under MITT (USFWS 2015b, 66 pp.). Air traffic at the air combat element beddown and the north ramp will include helicopter, vertical lift aircraft, fixed-wing, and unmanned aircraft arrivals and departures.

In addition, an air embarkation site is currently being built, as of March 2015, to serve as the passenger terminal for AAFB and temporary cargo storage. Air embarkation and disembarkation refers to the loading and unloading of passengers or cargo to and from aircraft. The passenger facilities are comparable to those of a small airport: luggage handling, waiting area, and ticket and documentation area. Cargo is staged for loading to aircraft or disbursement to warehouses or

individual commands. Currently the Air Force has air embarkation facilities at the south ramp of the airfield. Once the new facility is built, the existing facility will be closed. The site will operate 24 hours per day and 7 days per week.

The project will result in noise levels in excess of 60 dB over the Guam landscape. Northern Guam will be periodically exposed to noise levels in excess of 93 dB PK15. Peak sound levels are the calculated peak noise level, without frequency weighting, expected to be exceeded by 15 percent of all events that might occur.

Andersen South

The proposed project will result in the construction of a military operations in urban terrain training area, a portion of which will be a modular unit and another will be reconstructed from the existing unit; a logistics and administration area; a convoy course; an advanced motor vehicles operators course; an aviation training landing zone; an aviation and maneuver area landing zone; Pioneer Road; other range roads; a perimeter fence; main, secondary, and range road gates; and the realignment of Route 15 at Andersen South.

Andersen South Operations

Convoy operations, maneuver training for military operations in urban terrain, and general maneuver and air-ground operations will vary, but may occur up to 5 days per week, 45 weeks per year, day and night. The maximum estimate is approximately 250 to 300 USMC personnel will participate in maneuver training at Andersen South each week, for a total annual throughput of 11,250 to 13,500 personnel. Convoy operations will typically consist of 7 to 10 vehicles (e.g., high mobility multipurpose wheeled vehicles) traveling in tandem along an established course. Military operations in urban terrain includes transporting units to Andersen South by helicopter or vehicle, maneuvering toward the military operations in urban terrain complex on foot or in vehicle, and engaging in integrated training at the military operations in urban terrain complex. Military operations in urban terrain at the reconstructed training area (also referred to as the urban embassy component) will consist of 24 or more, multi-story concrete structures to simulate at least four city blocks.

The modular military operations in urban terrain (also referred to as the rural military operations in urban terrain) will consist of movable components that can be stacked and grouped into a number of configurations to present tactical situations to be overcome by training units. This modular military operations in urban terrain will consist of shipping containers that will be assembled on site to simulate a more rural village or set of suburban buildings located outside the core urban area. Forklifts or cranes will be used to reconfigure the modules of the military operations in urban terrain to add variety and diversity to training. The proposed military operations in urban terrain complex will include live-fire ranges, including a bleacher and shooting house that will be used for forced-entry training, and a hand grenade range and house. These will be suitable for units or organizations of up to 800 USMC personnel at a time, and will be used daily by 40 to 750 personnel. The military operations in urban terrain will operate day and night; night operations will comprise an estimated 15 percent of all operations. The military operations in urban terrain will be used by organizations based on Guam, transients, and visiting

regional allied forces. Units using the military operations in urban terrain may bivouac in the vicinity, or arrive and depart daily.

Typically, dry runs and individual skills training will occur prior to the military operations in urban terrain exercise, which will involve fire teams (smallest unit of infantry, typically four or fewer individuals), and squad drills (a group of 8 to 12 individuals). Types of weapons that will be authorized for use at the military operations in urban terrain will include M16, M4, M249, and M240. Blanks, simulators, smoke grenades, diversionary devices (improvised explosive devices and booby traps that release smoke when activated), special effects small arms marking system (similar to paintball), and multiple integrated laser engagement system (small laser receivers scattered over the uniform of an individual soldier, which detect when the soldier has been shined by another soldier's firearm laser) are used instead of ammunition and explosives that would be used in a real combat situation.

Tactical motor vehicle operator training is a continuous requirement for USMC units. The proposed advanced motor vehicle operations course will consist of a route along which a series of obstacles will be placed for driver trainees to negotiate. This will include obstacles simulating terrain features such as narrow bridges, serpentine courses, brake modulation blocks, river crossing, side slope, pot holes, curb and ditch crossing, humps (similar to moguls on a ski slope), and narrow urban driving. The obstacles are connected with unpaved roads. The capacity of the advanced motor vehicle operations course facility will range from 25 to 60 personnel and will be used for individual, section, squad, or platoon training. An estimated 20 drivers per week will train at the advanced motor vehicle operations course, primarily with high mobility multipurpose wheeled vehicles. At two drivers per vehicle, an estimated 10 high mobility multipurpose wheeled vehicles will use the course during training events.

Convoy training consists of simulated threats and tactical scenarios to train in various defensive techniques. This area of Andersen South is currently used by the Air Force for expeditionary airfield and military operations in urban terrain training which has similarities to the proposed maneuver area training. The convoy training course is 2.5 mi (4 km) and will use existing and new roadways (see Andersen South construction above) within areas identified for the maneuver training space. All existing roads will be open to motor vehicle use associated with maneuver area training; this will primarily be wheeled vehicles, but occasionally a tracked vehicle may be used in maneuver area training at Andersen South. The area will continue to support Air Force training, while also accommodating Marine Corps training requirements. Access to the site will be by vehicle or air lift. Air lifts will typically involve two to four CH-53 helicopters dropping off and picking up personnel twice a week.

Andersen South will support landing zones for aviation training and include helicopter support team training for ground units. Personnel train in rappelling from the helicopter and procedures that will be used in inserting and extracting troops via helicopter at combat locations. The air operation events associated with this air-ground training will typically consist of a pass for orientation, followed by a downwind approach, hovering at 30 ft (9 m) above ground level for approximately one minute at a designated landing zone and a departure. Since the maneuver area aviation training operations will be a component of training to meet the aviation training requirements, they are also described below under aviation training. Helicopter-insertion extraction activities include fast rope, rappelling, helocasting, and parachute operations.

Helicopter insertion-extraction training operations will involve one pass for landing zone orientation, followed by an approach of the landing zone, hovering at approximately 30 ft (9 m) above ground level for approximately one minute, and then departing the landing zone. During each training event, approximately three helicopter insertion-extraction operations will be conducted at one or more closely located landing zones. Approximately 114 helicopter insertion- extraction events will occur at Andersen South per year. Confined area landing, external loads, and maneuver lift (see descriptions above) training will also occur on Andersen South at a frequency of 125, 63, and 720 events per year, respectively.

Shooting house operations, which are proposed to be located in Andersen South, are conducted in an enclosed structure and provide training in close-quarter skills, like room clearing and hallway navigation. No explosives are used; however, live-fire training operations with the 5.56 mm rifle will be authorized at the facility.

Naval Base Guam

Naval Base Guam (NBG) is located along the southern side of Apra Harbor on the western coast of Guam. The civilian Port of Guam flanks the northern side of the Harbor. The 2010 DON BO carry-over activities constructed and implemented within the NBG are described below. As of March 2015, the working dog kennel and the Apra Harbor wharf and utility upgrades and associated dredging and dredge disposal management activities are under construction.

Naval Base Guam Construction Projects

In-water ship berthing and embarkation areas, staging areas, an amphibious craft laydown area, a military working dog kennel relocation, a medical and dental clinic, washdown facilities, brown treesnake barriers, and quarantine areas will be developed at the NBG. In addition, a U.S. Coast Guard berthing and crew support building will be relocated to an area that is not currently forested. The military working dog kennel will be relocated from its existing site to a new site on NBG. The proposed project location is in an existing laydown area for base maintenance with existing access roads and utility tie-ins. Associated with the aircraft carrier berthing at NBG are the shore-side facilities (recreation, gathering, laundry, waiting for transportation, and food and beverage sales), staging areas, new buildings, and parking. The Apra Branch Medical and Dental Clinic will be built on a previously disturbed area that is currently vacant. The Morale, Welfare, and Recreation area will be developed to provide food and beverage booths, seating for 500 people, 40 phone bank seats, 100 stalls for visitor and rental car parking, portable restrooms, laundry facilities, temporary lighting, and trash dumpsters.

All facilities will have security lights mounted on buildings or steel poles. Lighting along the wharves will consist of 1,000-watt high pressure sodium floodlights mounted on new or existing poles. Lighting will be shielded and aimed such that the majority of the illumination will be directed towards the wharf deck, extending over water approximately 100 ft (30.5 m). All actions related to development and improvement of waterfront facilities will occur in currently paved or landscaped areas. All utility distribution lines and ductwork will be located underground, generally within existing utility corridors.

The DON will develop permanent and temporary washdown, quarantine, and inspection areas at arrival areas on Guam at Apra Harbor (ship and amphibious vehicle loading and unloading) and AAFB (DON 2010c, p. 70) as follows.

1. A washdown, quarantine, and inspection facility will be built at Apra Harbor within 600 ft (183 m) of Victor Wharf to reduce the risk of exposure to invasive species after leaving the clean, biosecure area. During construction, invasive species and debris will be removed from the site. Prior to operation, the biosecure area will be inspected and will only begin operations when the area is invasive species-free. These facilities will provide vehicle cargo quarantine, inspection, and storage areas. These areas will be constructed with a brown treesnake barrier and active trapping for brown treesnakes will occur. These facilities will provide a pre-wash down area, vacuum equipment, wash racks (raised platforms with ramps at either end that facilitate cleaning and inspection of undercarriages), an inspection building, and fenced area that will meet the requirements for the use of inspection dogs and a cargo loading and inspection area. Specifically, these facilities will be built in a designated paved area with a wash down area and sufficient space for segregating "clean" from "dirty" equipment, cargo, and vehicles. The areas will be surrounded by brown treesnake barriers following specifications received from the Service: The barriers will be 4.5 ft (1.4 m) tall; made from pre-cast concrete with an outward projecting lip to deter snakes; the barriers will have only two gates providing one-way flow of traffic through the site; each gate made from sliding chain-link with fabric barriers or comparable materials to prevent snake ingress and egress.

2. When in Apra Harbor, the vehicles and equipment unloaded or loaded onto a ship will be inspected and receive a wash down on arrival and departure to prevent introduction of any pest or invasive species that may present a potential threat to agriculture, public health, or the natural resources of Guam or other Pacific Islands. All wash downs will be conducted and supervised by trained personnel in accordance with Armed Forces Technical Guide 31 (2008). Personnel from USDA may participate in inspections and brown treesnake inspections will be conducted with involvement of USDA Animal and Plant Health Inspection Service (APHIS) personnel. Vehicles will be inspected (internally and externally) prior to passing into the biosecure area. The water used to wash vehicles will be captured and circulated through filters to prevent pests from spreading. All waste on board ships will continue to be steam sterilized prior to disposal in regulated landfills in accordance with base operating procedures.

3. Supplies for the Coast Guard Cutters are delivered to the wharves from existing DON supply warehouses where all supplies and material have undergone required USDA inspections upon arrival and before being transferred out of the warehouse and onto a U.S. Coast Guard ship. The U.S. Coast Guard ships will not be offloading supplies onto Guam from other locations (DON 2010c, p. 79).

4. Truck traffic at the wharf will be required to re-supply ships (DON 2010c, p. 85). Trucks may be from DON Supply or direct from commercial vendors. Equipment to move cargo will be brought to the wharf as needed. When an aircraft carrier is not berthed, the Port Operations building will be used for storage. All equipment and cargo will go through

inspection procedures prior to being brought into "clean" areas or being loaded on to ships, regardless of vendor.

5. A washdown, quarantine, and inspection facility will also be built at the amphibious vehicle laydown area in Apra Harbor to reduce the risk of exposure to invasive species after leaving the clean, biosecure area. This facility will be adjacent to the shore so that amphibious craft can drive into the washdown, quarantine, and inspection facility. This facility will be built to the specifications described above for Victor Wharf with modifications to accommodate amphibious vehicles, specifically: the laydown area will have dedicated ramps for landing craft air cushion and amphibious assault vehicles in the quarantine area.

6. Typically, the Amphibious Task Force will arrive fully supplied to meet all training requirements or will be replenished as needed prior to training in the CNMI. If cargo is loaded or unloaded, inspection is required as described above for Victor Wharf. Cargo will be loaded and unloaded in the laydown area which will be of sufficient size to segregate "clean" from "dirty" cargos. If there is a training mission on Guam, the trucks will drive off the ships' stern ramps (and be inspected as described above). Other cargo may be offloaded by mobile crane. After inspection, cargo may be temporarily stored in a "clean" material handling equipment at the waterfront.

7. There are several projects in Apra Harbor. For all facilities, the DON will attempt to include USDA APHIS at the earliest possible time to plan for brown treesnake inspections. Planning for cargo storage will include considerations of the length of time for storage, risk of brown treesnake or other invasive species, and origin and destination of cargo. These considerations need to be vetted through the Biological Monitor (who will coordinate with other partners. Permanent barriers and moveable brown treesnake barriers will be used as the situation dictates.

8. The DON will develop permanent and temporary quarantine and inspection areas at a new Air Embarkation and Disembarkation area at Andersen Main Base to load and unload passengers and cargo from aircraft (DON 2010c, p. 62-63). USDA APHIS will be included in the design of this facility as early as possible to assist with planning. This facility will be surrounded by a brown treesnake barrier built to the specifications described above and will have inspection and quarantine areas to separate "clean" from "dirty" areas such that all aircraft, baggage, equipment, and cargo are 100 percent inspected upon arrival and 100 percent inspected upon departure. The aircraft carrier berthing will bring up to 59 aircraft to Guam that may beddown at AAFB. All transient aircraft will follow all existing invasive species inspection protocols, including brown treesnake protocols (DON 2010c, p. 83).

Naval Base Guam Operations

All amphibious training operations and conservation measures are assessed under the MITT Biological Opinion (USFWS 2015b, 66 pp.). Though new facilities will be constructed due to the proposed project, no additional amphibious training will occur in undisturbed areas, either

new or increased frequency or tempo is proposed under the proposed project. Therefore, amphibious training will not be analyzed within this Biological Opinion.

New aviation training, called external load, will occur at Orote Airfield on NBG. The training requires access to pre-positioned cargo for practice, and ground access is needed for ground support team personnel. External loads cannot be carried across public roads or populated areas. External load training operations will involve one pass for landing zone orientation, followed by an approach of the landing zone, hovering approximately 30 ft (9 m) above ground level for approximately one minute while the ground support team attaches a load (e.g., concrete block, items in a cargo net, or a vehicle), departure of the landing zone vicinity with the load in tow, flying with the load in an arc, then returning to the landing zone with the load, and hovering for approximately 30 seconds while the ground support team retrieves the equipment, and then departing the landing zone vicinity. During each event, these operations will typically involve five repeated attachments and detachments of external loads at the same landing zone where the ground support team is positioned. Ground support teams will include up to 40 personnel at one time and will support landing zone operations. Approximately 10 to 12 wheeled vehicles (e.g., high mobility multipurpose wheeled vehicles) will be used by these teams. External load training will involve pick up and return from the same location on Guam.

Naval Munitions Site Operations

Comment [F1]: Delete first paragraph per Coralie's email, Feb 1, 2016

Terrain flight, ground threat reaction, defensive maneuvering, confined area landing, and external load training will occur at the NMS. Terrain flights require a route with varying terrain for night flight with night-vision goggles, at 50 to 200 ft (15 to 61 m) above ground level. Training for terrain flights will occur only within the southern portion of the NMS, south of the southern extent of Fena Reservoir. Aircraft will leave AAFB and transit to southern Guam using standard military flight procedures (i.e., greater than 1,000 ft [305 m] above ground level). Aircraft may fly over land or over water on their way to the NMS. A typical training event may involve an aircraft leaving AAFB, moving to the east over the ocean, traveling along the coast at an altitude greater than 1,000 ft (305 m) until approximately the Talofofo River, and then flying up the river to the NMS still at an altitude equal to or greater than 1,000 ft (305 m). Flights may go up the Ugum River at altitudes of 1,000 ft (305 m) or greater above ground level until they reach 9,843 ft (3,000 m) from the mouth of the river at Highway 4 and then flights may conduct low-level terrain flights. Once the aircraft crosses into the NMS below Fena Reservoir (training restriction line), pilots will then be authorized to conduct low-level (50 to 200 ft (15 to 61 m) above ground level) terrain flights within the southern NMS. Low-level flights will not occur over the munitions bunkers, the main NMS, the area to the east of the munitions bunkers, over Fena Reservoir, or over the Almagosa Springs.

Ground threat reaction training requires a tactical flight maneuver area or route (similar to terrain flight routes) where ground-based electromagnetic radiation threat simulators may be placed. Defensive maneuvers are also conducted along a route over land or water. Differing helicopter types (AH-1, CH-53E, UH-1) and the MV-22 tilt rotor aircraft, will be used to conduct terrain flights, ground threat reaction, and defensive maneuvers training; however, terrain flights training operations are low altitude tactics and the ground threat reaction and defensive maneuvers training is conducted more in a tactical navigation area than along a route. Ground threat reaction is also low-altitude training like terrain flights, while defensive maneuver training

is higher in altitude (equal to or greater than 1,000 ft [305 m] above ground level). Approximately 100 terrain flights, 94 ground threat reaction, 94 defensive maneuvers, and 1,104 maneuver lift flights per year will occur in the NMS.

Confined area landing training operations will also occur at the NMS. Confined area landing training consists of one pass of the landing zone for orientation, a downwind approach, followed by the landing, and takeoff. To meet qualification requirements, confined area landing training events typically will have five associated operations. Typically, a number of different, closely located landing zones, will be used during the training event. There will be approximately 125 confined area landing training operations per year at the NMS. Approximately 63 external load training operations per year will also occur at the NMS and are described under "Naval Base Guam Operations".

Roadways

The proposed road projects will enable and improve roadway connectivity, capacity, and pavement strength for military construction and deployment in support of the proposed project. Some of these road projects will be funded by DoD pursuant to the Defense Access Roads program. The projects that are not funded by DoD will be the responsibility of the Government of Guam Department of Public Works or the Federal Highways Administration. Logistical routes for construction-related transport will connect the Port of Guam with NBG, AAFB, the proposed main cantonment, the NMS, and existing concrete batch plants, rock quarries, and precast concrete panel fabrication sites are associated with the military buildup on Guam.

In addition to improvements to the construction routes, increased traffic associated with the presence of the military personnel and their dependents will require roadway modifications. As a result of the recent transportation and traffic studies on the island of Guam, 50 individual road projects have been proposed but would occur within urban areas. The more extensive roadwork projects will either occur within previously developed areas of Guam such as residential and commercial areas, or they will not entail impacts to woody vegetation or other natural resources potentially utilized by listed species (for instance, pavement strengthening will not require any additional disturbance to areas outside of the existing roadbed) (Table 4). However, the Agana Bridge 1 Replacement Project occurs along Route 1 and has the potential to impact wetland habitat.

Table 4. DON Actions Associated with the Military Relocation to Guam that are Carried Over from the 2010 DON BO (modified from Table 1-1, DON 2014a, p. 3)

Location	Action
AAFB	Location for the Marine Corps Air Combat Element and construction of associated facilities at AAFB North Ramp
AAFB	Construction of air embarkation facilities at AAFB South Ramp
AAFB	Construction of the North Gate and access road at AAFB, including a new Entry Control Point facility
Andersen South	Development of a training range complex to include maneuver training and landing zones
Apra Harbor	Waterfront functions at Apra Harbor to support embarkation, including wharf and utility upgrades, and associated berth dredging and dredge disposal management

Apra Harbor	Relocation of Military Working Dog Kennel
Apra Harbor	Relocation of U.S. Coast Guard
Apra Harbor	New Medical Clinic
Apra Harbor	Apra Harbor Embark Operations
Naval Munitions Site	Training activities, including aviation training and nonfiring operations training
Naval Munitions Site	Access to the NAVMAG area using the existing hiking trail as the access road (No Construction Required)
Naval Munitions Site	Use of Parsons Road area for the location of additional ammunition storage at NAVMAG
Roadway Project (by FHWA and Guam Department of Public Works[GDPW])	Route 1 and Route 8 intersection and improvement (Hagåtña) ("Guam Road Network" [GRN]1) – (Part of Hagåtña Bridge Replacement Project Scope)
Roadway Project(s)	Route 1 and Route 3 intersection and roadway improvements (Dededo) (GRN2)
Roadway Project	Replacement of Hagåtña (Agaña) Bridge #1 with reinforced concrete (GRN3)
Roadway Project	Route 11 roadway improvements from the port to Route 1, including pavement strengthening (GRN4)
Roadway Project	Widening of the Route 1 and Route 11 intersection, adding a second left turn lane and pavement strengthening (GRN5)

Term of the Proposed Action

The proposed project includes carry-over activities per the 2010 DON BO and new proposed activities as described above. The proposed construction activities would continue and occur over a 13-year period from 2015 to 2028. In addition, construction of the LFTRC is expected to be completed in January 2024. After the construction is completed, there will be about 6 months of equipment outfitting and testing before the range will be operational. There is no planned end date for the operation of the proposed action; therefore the duration of the project is indefinite.

CONSERVATION MEASURES TO AVOID OR MINIMIZE PROJECT IMPACTS

The project's conservation measures are designed to avoid or minimize project effects to listed species and their habitats or to contribute to the recovery of a listed species. The conservation measures are intended to represent a comprehensive summary of those measures that were proposed in the BA (DON 2014a), addendum to the BA (DON 2015b), and through discussions and email correspondence between the DON and the Service. Conservation measures are considered part of the proposed action and are vital to determining the scope of the proposed action. Implementation of conservation measures is required under the terms of the proposed action. The Service's effects analyses and determinations assume proposed project conservation measures will be implemented in full. Any changes to, modifications of, or failure to implement these conservation measures may result in a need to reinitiate this consultation. Modifications to aspects of the conservation measures described, that provide protection equal to or greater than the protection afforded by the measure, as it is proposed in this Project Description, may be substituted for those provided in this Biological Opinion with the Service's written concurrence. The conservation measures will be implemented prior to or concurrent with construction unless otherwise stated. After completing the conservation measures, the long-term management of the natural resources will be incorporated into the JRM INRMP (DON 2014a, p. 35). Based on discussions and meetings between the DON and Service, the Service understands that the

implementation of the conservation measures would be the responsibility of the DON; however conservation measures over the long-term would be managed by the JRM. The JRM's mission is to provide executive level installation management support to all DoD components and tenants through assigned regional installations on Guam and the Northern Mariana Islands in support of training in the Marianas.

General Conservation Measures to Contribute to the Recovery of Listed Species

1. Forest Enhancement

   The DON will implement a forest enhancement project on approximately 1,000 acres in Finegayan (Figure 3). The forest enhancement project will include:
   - Installation of ungulate exclusion fences around approximately 1,000 acres
   - Active removal of ungulates (i.e. trapping, snaring, shooting) with the goal of eradication within the fenced areas
   - Invasive plant removal
   - Propagation, planting, and establishment of dominant and rare species characteristic of native limestone forest habitats (e.g., *A. marianensis*, *G. mariannae*, *F. prolixa*, *M. citrifolia*, *C. micronesica*, *W. elliptica*, *S. nelsonii*, *H. longipetiolata*, *T. rotensis*)

   When a DON-related project is initiated that results in clearing of recovery habitat, a commensurate amount of forest enhancement will begin. The exact amount of recovery habitat that will be cleared will depend on final design specifications. The DON's forest enhancement project will enhance at least the same number of acres of recovery habitat as that cleared by the proposed action. The DON expects that approximately 1,000 acres of forest will need to be enhanced as part of the Project Description (Table 6). The timeline of initiation of forest enhancement projects will be based on the construction timeline for the proposed action. The first construction funds that are released for a project that will clear recovery habitat will also trigger the initiation of the forest enhancement funding. The sequence of forest enhancement will be: (1) ungulate exclusion fence, (2) ungulate removal, (3) invasive plant control, and (4) native plant establishment.

2. Guam *Serianthes* Adult Tree

   a. DON will propagate, plant, and maintain a minimum of 30 individuals of *Serianthes nelsonii*, parented from the Guam *Serianthes* adult tree, within the forest enhancement areas. Outplanting methods and maintenance success criteria will be developed in coordination with the DON and the Service. Over the long term, the outplanted individuals will be managed by JRM through the JRM INRMP to ensure survivorship into adulthood.

   b. DON will ensure that seeds from the Guam adult *Serianthes* tree will be collected by entities specified on recovery permits, provide storage for these seeds, and provide funds for *Serianthes* seed viability testing. Seed storage and viability testing shall occur at a certified facility (*e.g.*, National Center for Genetic Resources Preservation

or Lyon Arboretum). The DON will ensure the seeds are appropriately prepared or treated for shipping per the instructions of the certified facility.

c. The DON will protect the adult Guam *Serianthes* tree from ungulates through one of the following options.

   i. DON will construct and maintain a fence, with a minimum buffer of 100 feet, around the forested area surrounding the Guam adult *Serianthes* tree to protect the tree and its seedlings from ungulates. The DON will remove all ungulates from the fenced area either prior to the completion of the fence construction or within six months of the fence construction.

   OR

   ii. DON will construct and maintain a fence around the LFTRC to encompass the area within the existing Ritidian ungulate fence (per the ISR Strike Biological Opinion) and the Guam adult *Serianthes* tree. The DON will remove all ungulates from the fenced area either prior to the completion of the fence construction or within six months of the fence construction.

   iii. This fence shall be completed within two years of award of the construction for the portion of the LFTRC that removes the Ritidian ungulate fence.

d. DON would allow access to the *Serianthes* adult tree at NWF for seed collection and seedling rescue provided (1) the need to collect seed and/or rescue seedling has been coordinated in advance with the Service, AAFB, and JRM, and (2) adequate timing and coordination is permitted for DON to process the access request. Access requests would be coordinated through Range Control, which is the entity responsible for scheduling all training events on military ranges.

3. Sea Turtle Public Outreach and Coordination

The DON, in cooperation with the Guam Department of Aquatic and Wildlife Resources (DAWR), has undertaken an educational program to inform military and civilian personnel about sea turtle nesting and the potential impacts to the species from nest disturbance, direct harassment of sea turtles, beach disturbance, and other threats. The DON has developed and distributed sea turtle conservation posters, tri-fold brochures and activity booklets for elementary school children. These educational materials have been distributed to local dive shops on Guam, and will continue to be used and refined throughout the construction period of the proposed relocation. As part of the RSS training package, personnel would be directed to not interact with sea turtles and report all sightings to the Service and coordinate with the GNWR on nesting surveys at the Refuge.

Brown Treesnake Control and Suppression

The DON has initiated support for large-scale, long-term efforts to refine methods for brown treesnake (BTS) control that will reduce the snake population on a landscape level more cost-effectively and increase the efficacy of capturing snakes in low-density situations. In early FY12, the DON coordinated with the Service, USDA, and USGS on priority BTS projects. The development of a bait formulation for BTS suppression was determined to be the highest priority project need. The USDA National Wildlife Research Center (NWRC) was funded for a multi-year project by the DON at the start of fiscal year 2013 to implement the bait formulation project.

The DON will implement selected projects identified as priorities in the BTS Technical Working Group Strategic Plan that are compatible with the military mission on Guam for up to 10 years from the start of main cantonment construction, subject to Congressional funding guidelines and restrictions. DON and the Service acknowledge financial support is subject to the availability of funds, and no provision herein shall be interpreted to require obligation of payment of funds in violation of the Anti-Deficiency Act, 31 U.S.C Section 1341.

The DON's intent with these projects is to identify and use successful technology to severely suppress or eradicate brown treesnakes. DON will install a BTS barrier to exclude brown treesnakes from approximately 160 acres (65 ha) after the current experimental suppression activities within the Habitat Management Unit (HMU) has been determined to be successful. If the DON is successful at eradicating brown treesnakes within the 160 acres, the DON will install a second brown treesnake barrier to exclude brown treesnakes from approximately 300 acres (121 ha).

In response to decreased BTS densities, the rodent and feral cat population is expected to increase. In order to address this anticipated increase the DON will implement rodent and feral cat control. Rodent control would benefit recovery habitat as rodents consume seeds of native plants. Feral cat control would benefit the recovery of endangered birds as cats predate on native birds.

Conservation Measures to Minimize the Effects of Construction

1. Contractor Education Program. The DON contractor education program ensures that construction contractor personnel are informed of the biological resources in the project area, including invasive species, special-status species, avoidance measures, and reporting requirements. The measure is intended to prevent inadvertent effects to terrestrial biological resources due to lack of awareness of resource presence, sensitivities, and protective measures. The measure will be implemented during pre-construction and construction.

2. Contractor Plans and Specifications: All construction will occur within the limits of construction shown in the plans and specifications. This measure is intended to prevent additional habitat loss. The measure will be implemented during pre-construction and construction.

3. Pre-Construction Surveys for the Mariana Fruit Bat. For projects within or in the vicinity of suitable fruit bat habitat, surveys following the Service-approved JRM protocol (USFWS 2009a) will be conducted one week prior to the onset of work. If a fruit bat is present within 492 ft (150 m) of the project site, the work will be postponed until the bat has left the area. The measure is intended to prevent avoid and minimize potential effects to fruit bats, and will be implemented during pre-construction and construction.

4. Guam Landscaping Guidelines. Appropriate or non-invasive species will be planted in all new landscapes. This measure is intended to reduce potential effects associated with non-native vegetation, promote habitat for native species, reduce water consumption, and reduce the need for fertilizers. The measure will be implemented during construction.

5. LFTRC Range Berm Controls. LFTRC range berms will contain native or non-invasive herbaceous vegetation, and other engineering controls. This measure will help to manage stormwater runoff and control erosion, and the berm will minimize the number of bullets that may fall outside the range footprint. The measure will be implemented during construction.

6. Lighting Installation. Lighting will be designed to meet minimum safety, sustainability, antiterrorism, and force protection requirements. Hooded-lights will be used to the maximum extent practicable at all new roads and facilities within known sea turtle land habitat and fruit bat roost areas. Either hooded or "night-adapted" lights will be installed at the LFTRC. Illumination of forest, coastline, or beach will be consistent with range safety and security requirements and kept to an absolute minimum including the shielding of lights and directing lighting away from the forest or other wildlife habitat. This measure will be implemented during pre-construction, construction, and during operations.

7. Monitoring. The DON will be responsible for oversight of avoidance, minimization, and conservation measures implementation by the contractors for projects associated with the proposed action. The DON shall ensure that construction remains within the limits of construction and that sensitive resources are avoided, unless otherwise specified in this Project Description. This measure will be implemented during pre-construction, construction, and operations.

Conservation Measures to Minimize the Effects of Invasive Species

Regional Biosecurity Plan. To address invasive species pathways and encourage a more holistic approach to managing invasive species, the DON funded the development of a Regional Biosecurity Plan (RBP) for Micronesia and Hawaii (formerly referred to as the Micronesia Biosecurity Plan). Individual activities for various species will continue, but the DON and others agree it is more efficient to manage pathways and prescribe corrective measures for a suite of species which will be monitored at discrete control points over time. The RBP will provide stakeholders in Micronesia and Hawaii with a platform for coordination and integration of inter-agency invasive species management efforts such as control, interdiction, eradication, and research. The final RBP was completed in March 2015 (DON 2015c). Several of the

recommendations are incorporated into the Project Description as Best Management Practices (BMPs):

1. Onsite vegetation waste management procedures. Green waste will be handled by the contractors at designated laydown areas within the limits of construction. Contractors will be required to divert all the green waste. The larger-sized green waste consisting of trees and stumps will be processed into mulch and the smaller sized green waste will be processed into compost. A proposed green waste processing facility at NBG Landfill may also be used to process green waste generated during construction. The DoD will seek permit authorization from the GEPA for the proposed green waste processing facility. (Refer above to Construction – Utilities and Site Improvements for additional detail.)

2. DON's Final Guam Landscaping Guidelines. The DON has developed a manual providing landscaping design guidelines specific to appropriate plant selection and establishment for all the DON construction activities on Guam (DON 2011). This manual implements required DON policies including, but not limited to:
    a. use of native regional plants for landscaping;
    b. design, use, and promoting construction practices that minimize adverse effects on natural habitat;
    c. pollution prevention by reducing fertilizer and pesticide use, integrated pest management practices, recycling green waste (composting), and minimizing runoff;
    d. implementing efficient water practices; and
    e. preventing the introduction of invasive species.

    The above measure is intended to reduce potential effects associated with non-native vegetation, promote habitat for native species, reduce water consumption, and reduce the need for fertilizers.

3. Biosecurity outreach and education - The DON has initiated and will continue to implement a targeted, comprehensive outreach and education program for DoD and civilian populations for biosecurity focused on prevention. As a starting point, the DON contracted for the development of biosecurity outreach and education materials. The contractor has designed and produced an activity booklet, a two-sided, tri-fold, educational brochure with an associated poster that differentiates native from introduced species, defines invasive species, describes the known impacts of invasive species on native species and ecosystems, and what can be done to prevent and control invasive species. This effort also included the development of radio public service announcements (PSA) in three languages, and a television PSAs both of which aired for one month in September of 2013 during peak broadcasting times.

    The DON's biosecurity outreach and education program has already begun concurrent with the actions that were initiated under the 2010 EIS ROD (DON 2010b). The DON will develop additional informational videos, expand the radio PSAs broadcasts, and other print media as well as active public outreach concurrent with the arrival of the first major influx of USMC personnel in 2020 and continue for an additional 5 years.

4. HACCP planning. Hazard Analysis Critical Control Point (HACCP) planning is a pathway management tool that provides a comprehensive method to identify risks and focus procedures to prevent spread of species through pathways. Construction work could unintentionally spread non-target (potentially invasive) species. These non-targets could hitchhike on construction equipment or be included in shipments of materials and supplies from locations outside of Guam. The pathways used by invasive species to move into new locations are not always obvious. Many problematic species, diseases, and parasites have been transferred to new locations as undetected (and unplanned) hitchhikers. HACCP planning is a management tool that provides a structured method to identify risks and focus procedures. Understanding pathways and developing plans to reduce non-target species and prevent biological contamination is necessary to avoid unintended spread of species.

   In August of 2011, the DON sponsored several HACCP training courses for DON employees and construction contractors. A HACCP Planning Overview for Managers was held on August 8, 2011, and 2 two-day HACCP Planning courses were held August 9 through 12, 2011. Over 60 people attended the three courses. Additional trainings are held at the various project sites when there is worker turnover.

   a. All construction contracts will contain a requirement to develop a HACCP Plan which will identify risks and potential pathways for non-native species and will outline procedures for controlling and removing risks identified. Construction contractors are required to provide documentation that supports prevention, worker awareness training, and control of non-native invasive and pest species in the project area and efforts to prevent the movement of non-native invasive species to areas outside the project area, whether in a purposeful or inadvertent manner. The contractor is responsible for ensuring that employees receive applicable environmental and occupational health and safety training and keep up to date on regulatory requirements for specific training for the type of work to be conducted onsite.

   b. Construction contracts also will contain a requirement for inspections and proper re-use or disposal of vegetation to avoid contributing to the further spread of the coconut rhinoceros beetle. The construction contractors are to identify and implement control measures to prevent the inadvertent movement of non-native, invasive species to Guam and to and from the project site to other locations. The contractor is required to establish appropriate facilities that comply with all environmental laws and regulations, provide training for proper vehicle hygiene, and promptly take corrective and preventative actions for noncompliance. This includes vehicle washdown and inspection for soil and other materials and appropriate control measures are implemented to prevent the inadvertent movement of non-native invasive species from the project site to other locations.

   c. All HACCP planning and implementation related to the proposed action will be the responsibility of the awarded project contractor(s) to ensure that proper control measures are used throughout the construction activities to prevent the inadvertent movement of invasive species from one location to the project site,

and/or from the project site to other locations. It will be the responsibility of DON to review and concur with the development phase of the HACCP planning process to ensure proper compliance by these contractors.

d. HACCP plans will be approved and inspected by the DON.

5. Monitoring to evaluate effectiveness of HACCP

The DON shall provide training, review, and technical guidance on HACCP plan development, implementation, and revision during the construction phase of the buildup on Guam. The HACCP planning covers Guam-related rapid response actions. The DON contracted a baseline ecosystem monitoring study for projects on AAFB in 2011. Transects were focused on areas where newly introduced species were most likely to occur. The intent of the project was to establish a baseline of both native and nonnative plants present prior to the beginning of planned construction activities. The baseline will serve as a reference for subsequent monitoring efforts conducted concurrently with construction in order to aid in evaluating the success of implemented HAACCP plans. The baseline will also provide a basis of comparison relative abundance of invasive species during construction as well as whether any species detected during long-term monitoring are newly introduced or were present prior to the beginning of construction. The AAFB project was completed in December 2012.

To document the effectiveness of the HACCP implementation at construction sites, the DON has developed and implemented a long-term monitoring program for terrestrial vegetation. For any clearing of vegetation that is adjacent to or contiguous with recovery habitat, the perimeter and 98.4 ft (30 m) into the habitat will be surveyed to identify vegetation community species composition. This survey will be repeated six months and at one year after vegetation removal to ensure effectiveness of HACCP implementation (clean equipment, supplies, and materials) during construction activities. If new nonnative, invasive species are detected, the DON will notify the Service and the DON will develop and implement an eradication plan or control effort to prevent infestation.

The DON will develop an early detection and rapid response component for when an incipient invasive species is discovered in the proposed action area.

6. Brown treesnake interdiction

a. JRM has established a comprehensive brown treesnake interdiction program to ensure that military activities, including the transport of civilian and military personnel and equipment to and from Guam, do not contribute to the spread of brown treesnake to other islands or regions. Brown treesnake interdiction requirements are specified in DoD instructions (i.e., 36 Wing Instruction 32-7004, Brown Tree Snake Control Plan and COMNAVMAR Instruction 5090.10A, Brown Tree Snake Control and Interdiction Plan). The proposed action will continue to comply with these established procedures.

b. The DON will fund any increase of current federally funded brown treesnake interdiction measures (in Guam, CNMI, and Hawaii) where the increase is related to direct, indirect and induced growth caused by the USMC relocation to Guam. The fiscal year (FY) 2010 level of funding for the Federal interagency BTS interdiction effort on Guam, CNMI, and Hawaii and 2010 transportation levels associated with outbound cargo from Guam for the U.S. or U.S. territories will be used as the baseline. Any increase in funding will continue and become part of the DON's Brown Treesnake interdiction funding under authority of the Brown Tree Snake Control and Eradication Act (7 USC § 8501 note) (USFWS 2010a). The Service agrees that it is not DON's responsibility to fund increased interdiction measures *that are identified* more than one year after the end of the fiscal year both USMC relocation construction has ended and the permanent non-transient USMC military units have relocated to Guam. For the purposes of this Project Description, interdiction is defined as: "to hinder, prohibit, or prevent the brown treesnake from becoming established in new locations by conducting inspection and suppression processes."

   Since the original BO on DON was issued in 2010, the DON has worked with USDA and the Service to determine brown treesnake interdiction cost increases. Since July 2015, there has been no measurable increase in interdiction costs according to USDA.

c. Coordination with the USGS regarding the Brown Treesnake Research Closed Population Facility at NWF (located adjacent to the LFTRC and SDZ) – The DON will ensure through briefings or information packages that the personnel using the LFTRC know the importance of the facility and maintaining the integrity of the fence. An SOP will be developed as part of the Range Management Plan for the LFTRC to ensure the above and that USGS will be immediately notified in the event that the fence is accidentally damaged so the fence can be quickly repaired.

Conservation Measures to Minimize the Effects of Fire

The LFTRC and the Hand Grenade Range would be managed in accordance with Marine Corps Order (MCO) 3550.10, Policies and Procedures for Range Training Area Management, which addresses safe, efficient, effective, and environmentally sustainable use of the range area and includes fire management.

Fire management is a key component of range management. The DON goal is to reduce the effects of fires by limiting their frequency, size, and severity while still allowing the USMC to maintain a high level of combat readiness. In order to avoid or minimize impacts to listed species or recovery habitat, the range management plan will include the following elements of fire management:

1. A Fire Danger Rating System tailored to the specific military uses at the LFTRC and the local weather and fuel conditions will be established. Weather readings will be taken every hour by remote automated weather stations (RAWS) on the installation. This

information is immediately available to Range Control, who will use the output from the remote automated weather stations to determine the level of fire danger. This, in turn, determines any restrictions placed on military training for that hour. Restrictions are relayed to troops in the field via radio transmission. By restricting highly fire prone activities during periods of high fire danger, the likelihood of a fire start is reduced. Additionally, fires that are ignited are more likely to occur during periods of low or moderate fire danger, making them easier to control and extinguish.

2. Fuels management. All available fuel management techniques will be considered for fire break, fuel break, or fuel management area. Standard on-the-ground application is limited to mechanical cutting, herbicide application, and prescribed fire. If herbicide is to be applied, care will be taken to ensure there is no overspray into adjacent forested areas.

3. Locations and standards of fire breaks and fuel breaks. Fire breaks are similar to four-wheel-drive roads and are cleared of all vegetation to mineral soil. Fuel breaks are swaths of cut, burned, grazed or otherwise modified vegetation so that a fire's behavior is reduced. The fuel break widths are determined by fuels, topography, and prevailing winds. Fuel management corridors will be established and maintained providing areas through which fire will not carry. These corridors will provide several distinct areas where fire may be contained in order to prevent a catastrophic fire event. Each corridor will be approximately 100 to 300 m wide, although terrain, safety concerns, or protected resources may constrain the width in some areas. Fire breaks and fuel breaks shall be established immediately adjacent to the forest edge, along the outer perimeter of each range, so that there is no herbaceous vegetation along the edge of the forest.

   Fuel specifications within the corridor require that canopy cover not exceed 20 percent. Cover of fuel within the fuel management corridors will be measured at a scale of 10 meters. Within the fuel management corridors, no 10- by 10-meter area will have greater than 20 percent cover of fuel. Cover 'starts/stops' at the edge of a plant clump's canopy. The clump includes the dead herbaceous fuel on the ground. The frequency of a fuel break's upkeep is dependent on the speed of regrowth and/or colonization. If the vegetation within the range footprint is less than three feet tall, then no active management would be needed to maintain fuels at the < 3-ft height in the 40-60-m inner edge of the fuel break area.

4. Standard Operating Procedures (SOP). SOPs outline responsibilities for fire prevention, Fire Danger Rating System usage, staffing levels, equipment caches, fuel modifications, proper fire suppression actions, and post-fire reports. The SOPs also include fire prevention briefings to be given to range users prior to commencement of training, notification lists in case of fire, operational decision charts for fires, and maps of resources, fuels, fire breaks, and Fuel Management Areas.

5. Range Control approval and guidance. Prior to firing all pyrotechnics (including tracers), Range Control approval and guidance must be obtained. Fire Department and Range Control personnel will have the authority to stop live-fire training for non-compliance with any training regulation and/or SOPs.

6. Fire Suppression. Water trucks (pickup truck with a tank in the back) will be on-site as a first responder vehicle. Water trucks may be supported by a fire truck or helicopter, as warranted.

7. The Service will be provided a 30-day review period, from the date of receipt of the draft Range Management Plan (including the fire management plan), to provide comments and recommendations for the DON's consideration. The Fire Management Plan will be finalized for the LFTRC prior to operation of the first range at the LFTRC.

Conservation Measures to Minimize the Effects of Training

1. Aviation Training in NMS (see Naval Munitions Site Operations above in the Project Description). All aviation training will be conducted so that flights will approach the southern portion of the NMS over the Talofofo River watershed and Fena Reservoir at heights of 1,000 ft (305 m) or greater above ground level. Flights may go up the Ugum River at altitudes of 1,000 ft (305 m) or greater above ground level until they reach 9,843 ft (3,000 m) from the mouth of the river at Highway 4 and then flights may conduct low level terrain flights. Low-level training flights will be restricted to the southernmost portion of the NMS where Mariana swiftlets are not commonly present. This measure is intended to avoid and minimize effects to swiftlets, and will be implemented during operations.

Conservation Measures for the Newly Listed Species: Mariana eight-spot butterfly, *Bulbophyllum guamense*, *Cycas micronesica*, *Dendrobium guamense*, *Heritiera longipetiolata*, *Tabernaemontana rotensis*, and *Tuberolabium guamense*

The project's conservation measures are designed to avoid or minimize project effects to listed species and their habitats or to contribute to the recovery of a listed species. The DON has proposed the following measures for the newly listed species. The conservation measures are intended to represent a comprehensive summary of those measures that were proposed in the Conference Assessment (DON 2015a), a letter (DON 2015d), email correspondence (DON 2015b, e; DON 2016b) and discussions (DON 2015c, DON 2016a) between the DON and the Service.

Best Management Practices (DON 2015a, pp. 5, 9, 13, 14, 16, DON 2015b)

1. Contractor Education Program - The DON contractor education program is to ensure construction contractor personnel are informed of the biological resources in the project area, including invasive species, special-status species, avoidance measures, and reporting requirements (DON 2015a, p. 5). *Bulbophyllum guamense*, *Cycas micronesica*, *Tabernaemontana rotensis*, and *Hypolimnas octocula marianensis* will be included in the contractor education program to ensure construction personnel are aware of the species and the need to avoid inadvertent impacts to the species (DON 2015a, pp. 9, 13, 14, 16).

2. Protection of Cycads and Special-Status Plant Species - During construction activities, viable *Bulbophyllum guamense, Cycas micronesica*, *Dendrobium guamense*, and *Tuberolabium guamense* found within the project boundaries would be transplanted to the maximum extent practicable (DON 2015a, p. 5).

3. Protection of Mariana Eight-Spot Butterfly and Host Plants - Pre-construction butterfly and host plant surveys within suitable habitat within project boundaries (DON 2015a, p. 5). Salvage host plant parts (not the entire plant) and provide them to an expert in the identification of the larvae or eggs for identification and propagation of Mariana eight spot butterflies (DON 2015b).

4. Range Fire Management Plan - Prepare a Range Fire Management Plan, based on the DON's Wildland Fire Management Plan (Nelson 2008), to reduce fuel loads and fire potential on proposed ranges. The range Fire Management Plan would include protocols for monitoring fire conditions and adjusting training as needed (e.g., certain types of training may be disallowed under certain fire conditions); location and management of fire breaks, firefighting roads, and a fire fighting water system. Units undergoing training would be briefed on requirements suitable to the conditions of the day and protocols should a fire occur (*e.g.*, specifying how the range would shut down and how fire suppression action would be taken) (DON 2015a, p. 5).

Conservation Measures (DON 2015a, pp. 6-7, 9, 13, 14, 16; DON 2015c, DON 2015d, DON 2015e, DON 2016)

1. Fencing of the Haputo ERA Access Trail, Signage, and Education - The DON will fence the Haputo ERA to manage access in order to assist in maintaining the characteristics and integrity of the ERA. The fencing will prevent overuse and potential damage to terrestrial biological resources within the ERA. These measures are consistent with the goals and objectives of the Haputo ERA Management Plan (NAVFAC Marianas 2010).

   In addition, in accordance with the Haputo ERA Management Plan, the DON will: develop and install informational and educational signage on the cliffline above the Haputo ERA. The educational materials would educate military and civilian personnel on the sensitive biological resources within the Haputo ERA; and monitor visitor usage of the area to document usage and prevent overuse and potential damage to terrestrial biological resources (DON 2015a, pp. 6-7).

2. All cantonment components would be constructed on the upper plateau area of Finegayan and would not occur in the Haputo ERA. Construction personnel are issued base passes for official business only within proposed construction areas; these restrictions are specified in construction contracts (DON 2015a, p. 9).

3. DON will conduct pre-construction surveys of threatened and endangered species. If pre-construction surveys identify a listed species present in the construction area and the individuals cannot be avoided, healthy plants will be salvaged and housed in a native plant nursery or transplanted into nearby habitat or forest enhancement sites. The preferred option would be do what was done at J-200 where 5 of 9 cycads were salvaged and transplanted in suitable habitat adjacent to the project site. This may not be possible in every situation. DON is proposing to develop a native plant nursery on Finegayan for the storage and propagation of native plant species (DON 2015c).

The ability to salvage the plants would be dependent on the health of the plant and whether or not it would survive transplantation. A qualified arborist or horticulturist will make the determination of "health." Transplantation timing will be site specific. Plants that cannot be immediately transplanted shall be stored at a native plant nursery (DON 2015d).

4. Authorized Biologist: All authorized biologists are agents of the Department of the Navy and the Service and shall report directly to DON and the Service regarding all compliance issues; this includes all draft and final reports of non-compliance. Prior to commencing translocation of *Bulbophyllum guamense, Cycas micronesica, Dendrobium guamense, Heritiera longipetiolata, Tabernaemontana rotensis, Tuberolabium guamense*, or *Hypolimnas octocula marianensis*, DON shall submit the statement of qualifications for potential biologists to Service. The Service will provide a response (either concurrence or an explanation of why the person does not meet the qualifications) no later than 30 calendar days after statement is sent. If after 30 calendar days there is no response from the Service, DON will assume concurrence from the Service. The qualifications to work with the aforementioned species include the following:

   a. A bachelor's degree with an emphasis in botany, horticulture, entomology, ecology, or a related science;

   b. At least 100 documented hours of experience conducting propagation, translocation, transplantation, pest control and monitoring of the species or a closely related species;

   c. Applicant must provide contact information of three references familiar with their work related to b (above) (DON 2016a, b).

5. The authorized biologist shall record each observation of each species handled in annual monitoring reports. The authorized biologist also shall include what type of activities (e.g., propagation, translocation) was conducted on each species and if relocated to another area, provide the location. The reporting shall be included in the annual reports submitted by DON detailing the implementation of the Reasonable and Prudent Measures and Terms and Conditions. The first report shall be due at the end of October 2016. Annual reports due by the end of October shall be submitted as long as the proposed action is still operating (DON 2016a, b).

6. All *T. rotensis* would be avoided to the maximum extent practicable during proposed construction activities (DON 2015a, p. 14). It is reasonable to avoid the species as they are restricted to 6 locations within the water wells (2) and utility corridors (4) (DON 2015c).

7. *Heritiera longipetiolata* seed collection will occur (assuming the trees produce seeds) (DON 2015c).

8. DON potentially will avoid 100-150 individuals of the *T. guamense* and 1 individual of *D. guamense*. These plants that can be potentially avoided are located in the northern boundary of map enclosure of the December 15, 2015, DON letter to the FWS. The contractor will be encouraged to design the project to avoid *T. guamense* and *D. guamense*, however because of the potential geotechnical issues, sink holes, etc. issues

Comment [CCHCNSS2]: This is repetitive with #3 above...

DON will conduct pre-construction surveys of threatened and endangered species. If pre-construction surveys identify a listed species present in the construction area and the individuals cannot be avoided, healthy plants will be salvaged and housed in a native plant nursery or transplanted into nearby habitat or forest enhancement sites. The ability to salvage the plants would be dependent on the health of the plant and whether or not it would survive transplantation. A qualified arborist or horticulturist will make the determination of "health." Transplantation timing will be site specific. Plants that cannot be immediately transplanted shall be stored at a native plant nursery (DON 2015d).

Comment [CCHCNSS3]: We are revising these numbers and should have something for you tomorrow.

that are not apparent at this early stage; it is not known if some plants can be avoided until the DON is further in the design stage with the contractor. Individuals of *T. guamense* and *D. guamense* located within the middle or center of the map enclosure of the December 15, 2015, DON letter to the FWS, will not be avoided (DON 2015e).

9. The DON will plant the Mariana eight-spot host plants within the forest enhancement sites. The number of host plants that would be planted would be commensurate with the amount of host plants that are removed or developed over within the footprint of the LFTRC (DON 2015e).

Comment [CCHCNSS4]: This is repetitive with #3 above...

DON will conduct pre-construction surveys of threatened and endangered species. If pre-construction surveys identify a listed species present in the construction area and the individuals cannot be avoided, healthy plants will be salvaged and housed in a native plant nursery or transplanted into nearby habitat or forest enhancement sites. The ability to salvage the plants would be dependent on the health of the plant and whether or not it would survive transplantation. A qualified arborist or horticulturist will make the determination of "health." Transplantation timing will be site specific. Plants that cannot be immediately transplanted shall be stored at a native plant nursery (DON 2015d).

C. OTHER ACTIONS CONSIDERED FOR THE ANALYSIS

Although not part of the project description, a Memorandum of Agreement (MOA) between the DON and the Service regarding conservation of the Guam Micronesian kingfisher recovery habitat in northern Guam was signed by both parties on June 11, 2015. The purpose of the MOA is to ensure that a sufficient amount of suitable survival and recovery habitat (thereinafter "habitat") is conserved and managed in accordance with Federal agency obligations under section 7(a) of the ESA in northern Guam to support the reintroduction of the Guam Micronesian kingfisher (kingfisher). Another purpose of the MOA is to ensure that the DON meet the purpose and need for the proposed action to relocation the USMC to Guam (DON and Service 2015c, p. 1; also see Appendix B).

The Service has determined that approximately 8,178 total acres are required on lands currently under the custody and control of DoD in northern Guam to provide sufficient habitat for the reintroduction and eventual recovery of the kingfisher. To facilitate kingfisher recovery goals, the DON agrees to designate approximately 5,234 acres under the custody and control of the DoD in northern Guam as identified in the MOA (DON and Service 2015c). These 5,234 acres have been identified by the Service as habitat for the kingfisher needed to offset impacts of the Guam Military Relocation (the proposed action). The DON and Service recognize that the designation of the 5,234 acres may also provide a conservation benefit to other federally-listed species with similar habitat requirements (*e.g.*, Mariana crow, Mariana fruit bat) (DON and Service 2015c, p. 3).

For the 5,234 acres of land identified, the Service required enhanced management activity to ensure this habitat supports the reintroduction of the kingfisher. Accordingly, starting in fiscal year 2016, the DON commits to provide an additional $2 million per year of funding for management activities above execution year INRMP funding levels (adjusted for inflation) for the next ten years, subject to Congressional authorization and appropriation. Upon expiration of this ten-year period, parties will reassess progress of recovery efforts and future funding may be available from DON (see section V4 of MOA, DON and Service 2015c).

On December 18, 2015, the DON and Service modified the MOA to include an alternative configuration for the 5,234 acres of habitat for the kingfishers. A revised map was included with the modification (Appendix D).

D. ANALYTICAL FRAMEWORK FOR THE JEOPARDY/ADVERSE MODIFICATION ANALYSES

Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis of this Biological Opinion relies on four components: (1) *Status of the Species*, which evaluates the range-wide condition of the Guam Micronesian kingfisher (kingfisher), Mariana crow (crow), Guam rail (rail), Mariana fruit bat (bat), Mariana eight-spot butterfly (butterfly), *Serianthes nelsonii*, *Bulbophyllum guamense*, *Cycas micronesica*, *Dendrobium guamense*, *Heritiera longipetiolata*, *Tabernaemontana rotensis*, and *Tuberolabium guamense* and the factors responsible for that condition, and the survival and recovery needs of each species; (2) the *Environmental Baseline*, which evaluate the current condition of the kingfisher, crow, rail, bat, butterfly, *S. nelsonii*, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of each affected species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the kingfisher, crow, rail, bat, butterfly, *S. nelsonii*, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense*; and (4) *Cumulative Effects*; which evaluates the effects of future, non-Federal activities in the action area on the kingfisher, crow, rail, bat, butterfly, *S. nelsonii*, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense*.

In accordance with the policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the kingfisher, crow, rail, bat, butterfly , *S. nelsonii*, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the kingfisher, crow, rail, bat, butterfly, *S. nelsonii*, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* in the wild.

The jeopardy analysis in this Biological Opinion places an emphasis on consideration of the range-wide survival and recovery needs of the kingfisher, crow, rail, bat, butterfly, *S. nelsonii*, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *T. rotensis*, and *T. guamense* and the role of the action area in the survival and recovery of the these species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Adverse Modification Determination

This Biological Opinion does not rely on the regulatory definition of "destruction of adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this Biological Opinion relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the kingfisher, crow, and bat in terms of primary

constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat at the range-wide scale; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of affected critical habitat units in the action area; (3) the Effects of the Action, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For the purpose of the adverse modification determination, the effects of the proposed Federal action on kingfisher, crow, and bat critical habitats are evaluated in the context of the range-wide condition of the critical habitat at the range-wide scale, taking into account any cumulative effects, to determine if critical habitat at the range-wide scale would remain functional (or would retain the current ability for PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the kingfisher, crow, and the bat.

The analysis in this Biological Opinion places an emphasis on using the intended range-wide recovery function of kingfisher, crow, and bat critical habitats and the role of the action area relative to those intended functions as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

E. ACTION AREA

The term "action area" is defined in the implementing regulations for section 7 at 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action."

The action area for this consultation is the island of Guam (Figure 4). The specific areas likely to be affected, directly or indirectly, by the proposed action are discussed in detail in the BA. In addition to what is detailed in the BA, the following effects from the action may be Guam-wide: 1) effects from introduction of invasive species by the proposed action could spread throughout the whole island of Guam and 2) the population increase resulting from the proposed action will cause additional human disturbance throughout the island, including at recreation sites, hunting areas, traffic along roads, etc.

F. STATUS AND ENVIRONMENTAL BASELINE OF THE SPECIES

STATUS OF THE SPECIES

Status of the Guam Micronesian Kingfisher

Legal Status

The Guam Micronesian kingfisher (*Todiramphus cinnamominus cinnamominus*; "sihek" in Chamorro; hereafter, referred to as the kingfisher) was listed under the ESA as endangered in 1984 (USFWS 1984, 9 pp.). A revised recovery plan for the kingfisher was completed in 2008

(USFWS 2008a, 117 pp.). On October 28, 2004, the Service designated critical habitat for the kingfisher on approximately 376 ac (152 ha) in the fee simple portion of the GNWR (USFWS 2004, 117 pp.).

Species Description and Current Known Range

The kingfisher is endemic to the island of Guam in the Mariana Islands. Other subspecies, *Todiramphus* [=*Halcyon*] *c. pelewensis* and *T. c. reichenbachii*, exist on Palau (Republic of Palau) and Pohnpei (Federated States of Micronesia), respectively. The Guam subspecies is a small, sexually dimorphic forest kingfisher (Baker 1951, pp. 227–228). The adult male has a cinnamon-brown head, neck, upper back, and underparts. A black line extends around the back of the neck and the eye ring is black. The adult female resembles the male except that the upper breast is paler, as are the chin and throat, with the rest of the underparts and underwing coverts white (Jenkins 1983, p. 21). Immature birds have the crown washed in greenish-blue, and a whitish chin and throat. Underparts are buffy-white in the immature male, but may be paler in the female (Jenkins 1983, p. 21).

The kingfisher is extirpated in the wild on Guam but persists in captivity at the Guam DAWR facility and 24 U.S. mainland zoos and institutions. In response to the decline of Guam's native birds in the 1980s, the Association of Zoos and Aquariums (AZA) initiated the Guam Bird Rescue Project. Between 1984 and 1986, 29 kingfishers were translocated from Guam to zoos in the U.S. mainland to start a captive breeding program. The breeding program has been managed under the auspices of the AZA's *Micronesian Kingfisher Species Survival Plan* (Bahner et al. 1998, 54 pp.).

Life History

In the wild, kingfishers nest in cavities and feed primarily in mature, second growth limestone forest, and, to a lesser degree, in scrub limestone forest (Jenkins 1983, pp. 22–23). Kingfishers are also known to use coastal strand vegetation containing coconut palm as well as riparian habitat. However, Jenkins (1983, p. 22) reported the kingfisher was probably most common along the edges of mature limestone forest. Few data exist about specific nest sites of the kingfisher in the wild, but in one study in northern Guam (Marshall 1989), 16 nest sites were correlated with closed canopy cover and dense understory vegetation. The report by Marshall (1989) indicated that kingfisher nest cavities were excavated from the soft, decaying wood of standing dead trees averaging 43cm (17 in) in diameter (Marshall 1989, p. 475). Kingfisher nests have been reported in a number of tree species including *Ficus* spp. (banyan), *Cocos nucifera* (coconut), *Artocarpus* spp. (breadfruit), *Pisonia grandis* (umumu), and *Tristiropsis obtusangula* (faniok) (Baker 1951, p. 228; Jenkins 1983, p. 24; Marshall 1989, p. 475).

Kingfisher breeding activity in the wild is thought to be concentrated from December to July (Baker 1951, p. 228; Jenkins 1983, p. 24). Pairs may excavate their own nests in soft trees, arboreal termitaria (the nests of termites [*Nasutitermes* spp.]), arboreal fern root masses, or they may utilize available natural cavities such as broken tree limbs (Jenkins 1983, p. 24; Marshall 1989, p. 474). Jenkins (1983, p. 23) observed that some excavated cavities were never used as nesting sites, which suggests that the process of excavating nest sites may be important in pair-bond formation and maintenance.

Both male and female kingfishers incubate eggs, and brood and feed nestlings (Jenkins 1983, p. 24). Clutch sizes from wild populations (n=3) were either one or two eggs (Baker 1951, p. 228; Jenkins 1983, p. 24) and clutch sizes of one to three eggs have been reported in the captive population (Bahner et al. 1998, p. 21). Incubation, nestling, and fledgling periods for populations of kingfishers in the wild are unknown. However, incubation and nestling periods of captive birds averaged 22 and 33 days, respectively (Bahner et al. 1998, p. 21).

Although there is still more to learn about the breeding behavior of Guam Micronesian kingfishers, it is known that the nest excavation and courtship stages are crucial to successful reproduction. Kingfishers excavate multiple cavities in trees before selecting a suitable nest site. Courtship includes cavity excavation, male feeding the female, and vocal duetting (simultaneous calling between members of a pair). These activities are common and are thought to function in both pair-bond maintenance and territorial maintenance (USFWS 2008a, p. 24; Bahner et al. 1998, p. 18). The breeding season for this species on Guam is reported to range from December to June, however, within the managed population (in captivity) we have seen reproduction in all months of the year with January through July being the prime breeding period. During the breeding season, it is important to minimize disturbance within the territorial range of breeding pairs. Based on experience with the managed population, Guam kingfishers are especially sensitive to stress which would likely be increased by noise and disturbance, and compounded during the breeding season (B. Bahner, Philadelphia Zoo, pers. comm. 2015). Additionally, anything that disrupts the availability of prey items in their territory would be detrimental would negatively affect kingfishers. There is no known recommended buffer around active kingfisher nests; however in captivity nesting kingfishers have sometimes been monitored by cameras to avoid disturbing breeding birds (Bahner et al. 1998).

In the wild, the kingfisher is known to feed on invertebrates and small vertebrates, including insects, segmented worms, hermit crabs, skinks, geckoes, and possibly other small vertebrates (Marshall 1949, p. 210; Baker 1951, pp. 228–229; Jenkins 1983, p. 23). The species typically forages by perching motionless on exposed branches or telephone lines and swooping down to capture prey off the ground with their bill (Jenkins 1983, p. 24). They also will capture prey off nearby foliage and have been observed gleaning insects from bark (Maben 1982, p. 78).

Records of kingfisher distribution and intraspecific territorial behavior suggest this species maintains exclusive year-round territories in the wild (Jenkins 1983). Research and observations of the related Pohnpei kingfisher show this species has a "helper" social system where birds from previous nests may stay in the parental territory for several years. Pohnpei kingfishers defend their approximately 8.1 hectare (20 ac) territories from conspecifics (Kesler and Haig 2007a, pp. 386-387). Kesler and Haig (2007b, pp. 769–770) determined that kingfisher home ranges on Pohnpei consist of mixed forest and open areas and at least part of this area includes mature forest. It should be noted that Guam Micronesian kingfisher territories may differ from Pohnpei Micronesian kingfisher territories due to differences in forest structure (Mueller-Dombois and Fosberg 1998, pp. 269–275, 288–291). However, information on the related Pohnpei kingfisher as a surrogate species to the Guam Micronesian kingfisher represents the best available scientific information on kingfisher territory size and home ranges in the Pacific islands to date.

The life expectancy of the kingfisher in the wild is unknown. However, demographic data from captive kingfishers suggest that life history traits such as lifespan and reproductive span differ between the sexes. In captivity, males have a longer lifespan (23 years) than do females (15 years). Both males and females can reproduce at 1 year of age. In captivity, males have been observed to breed as old as 19 years, while females have not been observed to breed beyond the age of 12 (AZA 2014, p. 4).

Current Status

The kingfisher is currently extirpated from the wild. It was considered "fairly common" and occurred throughout forested areas on Guam in 1945 (Baker 1951, p. 229). Populations in southern and central Guam disappeared by the 1960s (Jenkins 1983, p. 25) and 3,023 individuals were recorded in 1981 in northern Guam (Engbring and Ramsey 1984, p. 34). The northern Guam population subsequently declined rapidly, and by 1985, fewer than 30 individuals were recorded on Guam (Marshall 1989, p. 474) and the taxon was considered extirpated from the wild by 1988 (Wiles et al. 2003, p. 1,354). Predation by the brown treesnake is considered the main cause of the decline of the kingfisher population on Guam (Savidge 1987, USFWS 2008a, p. iv). Between 1984 and 1986, 29 kingfishers were captured and sent to zoological institutions in the U.S. mainland (Hutchins et al. 1996, p. 4). Currently, the captive population consists of 155 adult kingfishers (86 males and 69 females) in captive rearing facilities (GMKF Recovery Team 2015, p.3). In 2015, the Service provided funding to the Boorkfield Zoo in Illinois to install 30 new cages, which would increase the population by more than 25 percent.

The goal of the captive kingfisher propagation program is to grow the population while trying to maintain genetic diversity above 90 percent heterozygosity. The current captive population was founded by 16 of the 29 individuals brought into captivity. The current gene diversity is 87.74 percent; with the potential to reach 92.45 percent (AZA 2014, p. 4).

Threats (see also the General Environmental Baseline section of this Opinion)

The Service intends to reintroduce the kingfisher into the wild on Guam. For that effort to be successful, the following threats need to be addressed. The following discussion is adapted from Service (2014, p. 2):

- Loss or Degradation of Habitat
    - Incremental habitat loss due to fire, especially in southern Guam (Department of Agriculture 2010), and urban and agricultural development is increasingly threatening the long-term conservation of the kingfisher because of the continued loss of habitat on Guam.
    - Ongoing and proposed plans by DoD to expand training and operations on Guam are threatening much of the remaining kingfisher habitat.
    - The persistence of large, feral ungulate populations is likely to further degrade remaining forest habitats, thus lowering their value for kingfisher recovery.
- Predation

  - Predation risk from brown treesnakes currently prevents effective reintroduction of the kingfisher to Guam.

- Stochastic Events

  - Typhoons will continue to degrade forest and the affected forest areas may require several years to regenerate.
  - Although birds in the Mariana Islands have evolved with typhoons, typhoons in concert with low population numbers, habitat loss, and behavioral and genetic consequences of captive breeding could negatively affect the recovery of the Guam Micronesian kingfisher.
  - Climate models indicate that hurricanes in the northwestern Pacific are expected to increase in intensity, frequency, and duration by 2200 and continue to increase further into the future (Emanuel et al. 2008, p. 360). These storm increases will likely have a significant effect on habitat and survival of listed species on Guam.

Survival and Recovery Needs

For purposes of this Opinion, the "survival condition" of the kingfisher in the wild represents the level of reproduction, numbers, and distribution necessary to support a persistent population on Guam that is fully protected by the ESA. For purposes of this Opinion, the "recovery condition" of the kingfisher is the survival condition where the threats to the species have been addressed such that the protections of the ESA are no longer necessary to ensure perpetuation of the survival condition of the kingfisher in the wild.

The recovery plan (USFWS 2008a) for the kingfisher calls for a total viable population of 2,000 adult kingfishers on Guam within two subpopulations of 1,000 adults each. One subpopulation would be located in northern Guam, and one subpopulation would be located in southern Guam to reduce the risk of a second extirpation event due to random, stochastic events. For the purpose of population viability modeling to identify viable subpopulations that would meet a minimum population growth rate to achieve recovery, we assumed that the 1,000 adults are 500 breeding pairs (see Environmental Baseline section for kingfisher). The area requirements for a breeding pair (approximately 20.0 acres; Kesler and Haig, 2007a) is less than the combined area for an individual non-breeding adult male (average of 17.5 acres; Kesler and Haig 2007a) and an individual non-breeding adult female (average of 14.1 acres; Kesler and Haig 2007a). Thus the total area for recovery will be minimized by assuming all 1,000 adults are in breeding pairs. Additional area may be needed if a significant number of adult kingfishers forgo breeding in any year.

Each subpopulation must have brown treesnakes and other predators controlled to a level where establishment of a sustainable kingfisher population is feasible and habitat to support this population level must be protected and managed. In the interim, the kingfisher also may need to be established in the wild on other islands outside their native range to reduce the detrimental consequences of long-term captivity and to spread the risk from stochastic events. Although any population(s) established on other islands outside of the kingfisher's historical range would be considered temporary and would not contribute toward the recovery goal of two subpopulations

of 1,000 adults each on Guam, the ability to translocate wild birds versus captive birds to Guam would increase success of their recovery and survival on Guam. However, ultimately the recovery of the kingfisher is dependent on having adequate protected habitat free of threats on Guam to provide for the two subpopulations.

New management actions that have occurred in the last five years include:

- Construction of the 136-ac (55-ha) Habitat Management Unit (HMU) brown treesnake and ungulate exclosure fence at AAFB. Ungulate removal within the HMU is near completion by DoD per a section 7 consultation (USFWS 2006b).
- In 2014, the USDA-APHIS Wildlife Services, in coordination with the National Wildlife Research Center, the DoD-Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs, conducted a test of aerial application of a brown treesnake toxicant (acetaminophen) over forested areas in AAFB (Dorr et al. 2014, unpublished data). The results of this study within the approximately 136-acre (55-hectare) HMU on AAFB may result in the reduction of snake numbers to a low enough level to allow kingfishers to survive and reproduce within this snake-proofed area on Guam. The knowledge gained from this study will help with potential future improvements to the method and efficiency of the delivery of the acetaminophen to snakes on Guam.
- Construction of a 312-ac (112-ha) ungulate exclosure fence at NWF on AAFB by DoD per a Biological Opinion (USFWS 2006b).
- Construction of a multi-species exclosure fence within the fee simple portion of the GNWR at Ritidian Point, Guam.
- Construction of 4,400 ft of coated chain link fence along Route 2A on the perimeter of NBG by DoD per a Biological Opinion (USFWS 2010a). The fence provides an ungulate exclosure for the 3,114 ac (1,260 ha) of the main base of NBG. The fencing project is intended to effectively close off Orote peninsula from any new ungulate incursions and only entry control gates will be left unfenced. Ungulate removal within NBG is ongoing.

Recommendations for Future Actions (adapted from USFWS 2008a; USFWS 2014a, p. 3):

- Maintain or increase genetic diversity in the captive kingfisher population by implementing management strategies to exploit the potential gene diversity in the captive populations at the DAWR and AZA facilities.

- Predator Monitoring and Control
  - Continue efforts to develop and refine brown treesnake control techniques and support small-scale and large-scale control and/or eradication efforts on Guam.

- Reintroduction / Translocation
  - Develop a reintroduction plan for the kingfisher on Guam and set aside and protect recovery areas to facilitate its de-listing as soon as possible following the reintroduction of the kingfisher on Guam.

- Protection and restoration of kingfisher recovery habitat, including permanent protection as conservation areas and fencing to exclude brown treesnakes and ungulates.

Status of the Mariana Crow

Legal Status

The Mariana crow ("aga" in Chamorro) was listed as endangered throughout its range in 1984 and critical habitat was designated on Guam and Rota (USFWS 1984, pp. 33881-33885; 2004, pp. 62944-62990). No significant new information regarding the biological status has come to light since listing to warrant a change in the federal listing status of the Mariana crow. On October 28, 2004, the Service designated critical habitat for the Mariana crow on approximately 376 ac (152 ha) in the fee simple portion of the GNWR (USFWS 2004, 117 pp.).

Species Description and Known Range

The Mariana crow is the only member of the genus *Corvus* occurring in Micronesia (Jenkins 1983, p. 25). This species is known historically only from the islands of Rota and Guam, but is now extirpated from Guam. Preliminary genetic studies indicate that the Rota population is most likely a genetic subset of the Guam population (Tarr and Fleischer 1999, p. 946).

Life History and Population Dynamics

Mariana crows are omnivorous, and their diet includes a wide variety of plants and animals, including insect larvae, centipedes, grasshoppers, mole crickets, praying mantis, earwigs, hermit crabs, skinks, geckos, and bird eggs (Jenkins 1983, p. 26, 31; Tomback 1986, p. 399; Ha and Ha 2010a, pp. 8-10; Faegre *in press*). Faegre (*in press*) observed 619 food captures from approximately 36 wild crows and found that 14 percent of food captures were of plant-based foods, and 86 percent were from animal prey; 65 percent of animal prey were of insects or their larvae.

Mariana crows use forested habitats including limestone, strand, ravine, agricultural forests, and secondary forests (Jenkins 1983, p. 25, 32). However, evidence suggests they are most abundant in native limestone forests (Morton et al. 1999, p. 13, 41; Ha et al. 2011a, p. 25; Ha et al. 2011b, p. 240) and nests are found exclusively in native trees (Morton et al. 1999, p. 13, 33; Ha et al. 2011a, 2012, and 2013, pp. 32, 25, and 24-31, respectively). Nesting occurs in closed canopy forests in trees that are on average 17 cm in diameter at breast height, 8.7 m high, and 290 m from roads (Morton et al. 1999, p. 32).

Breeding likely occurs all year on Rota, while peak nesting activity generally occurs between August and February (Morton et al. 1999, p. 12; Ha et al. 2013, p. 31). A minimum of 65 days is necessary to build the nest, incubate the eggs, and rear the brood through fledging (Morton et al.1996, p. 21). Both parents generally participate in all aspects of breeding, although the female incubates most of the time (Morton et al. 1996, p. 21). The incubation period is 21 to 23 days, and the nestling period is 36 to 39 days (Morton et al. 1996, p. 21). After fledging, Mariana crows will typically remain in family groups until the following breeding season, a period that

averaged 241 days (SE = 33, median 197 days) for 15 banded family groups (Morton et al. 1996, p. 21). However, the period of parental attendance after fledging varies widely, from 99 to 537 days (USFWS 2005a, p. 19). Mariana crows will often reinitiate the nest cycle within two weeks after abandoning an empty nest, and within four weeks after losing a clutch or brood (USFWS 2005a, p. 18).

Mariana crows generally produce only a single brood per year; however, nest failure and other factors lead to multiple nest attempts each breeding season. From 1996 to 1999, 32 crow pairs on Rota constructed a mean of 2.2 nests per year (SE = 0.14, n = 78), with one pair building as many as seven nests in one season; however, not all nests resulted in egg deposition (Morton et al. 1999, p. 14, 36). Zarones et al. (2014, pp. 6-7) examined 204 active nests on Rota from the 1996 to 2009 breeding seasons and documented, on average, a clutch size of 2.57 (SD = 0.8, n = 82), 1.39 nestlings per nest that hatched (SD = 0.5, n = 106), 1.25 fledglings per nest that fledged (SD = 0.4, n = 68), and an overall nest success rate of 25.7 percent. The proportion of monitored pairs that produced at least one fledgling per breeding season ranged from 0.21 to 0.73, with an overall rate of 0.49 over the entire study period. During the 2013 breeding season, 16 of the 46 pairs (35 percent) successfully fledged young (Kroner 2014, p. 3). The estimated pair breeding success rate for 2013 was down from 60 percent in 2008 (Zarones et al. 2014, p. 7) and 57 percent in 2012 (Ha et al. 2013, pp. 59-60).

Little is known regarding lifespan, age of sexual maturity, and length of reproductive life in Mariana crows. The oldest known wild crow was at least 18 years old when last observed on Rota in 2014 (A. Kroner and S. Faegre, University of Washington, pers. comm. 2014). This same adult male was at least 17 years old when he was last seen feeding a fledgling in 2013. Another male was 14 years old when he last produced a chick in 2009, and a 15-year-old female was observed with a fledgling in 2014 (S. Faegre, University of Washington, pers. comm. 2014). Although it was originally thought that Mariana crows begin breeding around 3.5 years old (Morton et al. 1999, p. 2), a radio-tagged male Mariana crow built his first nest at 16 months of age and was observed feeding a fledging at 21 months of age. Two other banded crows, a female and a male, successfully fledged young in 2011 and 2013, just after they turned two years old (A. Kroner and S. Faegre, University of Washington, pers. comm. 2014). A banded female was observed at a recently failed nest when she was approximately 1.5 years old (A. Kroner and S. Faegre, University of Washington, pers. comm. 2014).

Survival to one year of age for male and female Mariana crows banded on Rota between 1990 and 2010 was 49.9 and 75.2 percent, respectively (Ha et al. 2010b, p. 25). Annual survivorship for adult males and females was 83.5 and 82.7 percent, respectively (Ha et al. 2010b, pp. 25-26). Recent analyses suggest that first-year survival has increased to 0.65 and adult survival has remained steady at about 0.80 since 2010 (R. Ha, University of Washington, pers. comm. 2014).

Mariana crows are known to be highly susceptible to disturbance from human activities (Morton 1996, p. 60, 62, 72; Ha, R. 2015, pers. com.; Ha et al. 2011, p. 5). Based on observations of disturbance of crow nests on Guam, Morton (1996, p. 72) recommended a 300-meter radius for a buffer zone around active crow nests; Morton's recommendations were based on observations of crows reacting to facility/grounds maintenance, brown treesnake trapping, research activities, loud music, and human voices. One Mariana crow nest on Guam was abandoned due to disturbance from maintenance activity and from radio noise coming from a sound system 150

meters away (Morton 1996, p. 62). Ha et al. (2011, p. 236) found that nest sites were always greater than 300 meters from any buildings, and that actual nest sites were almost twice as far from roads and buildings as random sites.

Distribution, Status, and Threats

Guam
Although the Mariana crow was once present throughout Guam (Baker 1951, p. 246), the population has been declining since at least the 1960's (Engbring and Ramsey 1984, p. 30; Engbring et al. 1986, p. 92) and is now extirpated. The last known crow of Guam origin was observed in 2001, and the last known wild Mariana crow that was captive-reared from Rota and released on Guam was observed in 2012 (J. Quitugua, DAWR, pers. comm. 2014). Predation by brown treesnakes is the overriding factor in the extirpation of Mariana crows from Guam (USFWS 2005a).

Suitable habitat for Mariana crows is still present on Guam. As described below in the Environmental Baseline for the Mariana Crow, we estimate that 24,919 acres (10,084 ha) of Mariana crow habitat is left on Guam. More information on crow habitat is provided in the Environmental Baseline for the Mariana Crow section below.

Rota
In 1976, Mariana crows were considered relatively common and widely distributed on Rota (Pratt et al. 1979, p. 234). Reanalysis of the first island-wide survey for the species on Rota in 1982 using current density estimate methods resulted in a population estimate of 1,491 birds (815-3115 birds, 95 percent confidence interval) (Engbring et al. 1986, pp. 92-95; F. Amidon, USFWS, pers. comm. 2014). The most recent island-wide pair survey on Rota was conducted during the 2013 breeding season and documented 46 breeding pairs; an approximate 94 percent decrease in the population since 1982 (Kroner 2014, p. 3). The primary threats to the Mariana crow on Rota are suspected to be predation by cats, human persecution, and habitat destruction (USFWS 2014b, p. 3), but evidence is limited and substantially more research is needed.

Mariana crow telemetry studies were conducted from 2009-2013 and will begin again in the 2014-2015 nesting season. Before telemetry studies began on Rota there was no evidence available to suggest feral cats (*Felis silvestris*) were predating crows. The lack of evidence was likely due to high scavenging and decomposition rates, and the extreme unlikelihood of finding a fresh carcass in time to retrieve any useful information regarding cause of death. Since telemetry efforts began, nine recently-deceased, radio-tagged Mariana crows have been found with evidence suggesting cat predation, and one untagged adult was taken in for care and later died after receiving what a veterinarian confirmed as an infected cat bite (Ha et al. 2013, pp. 5-6).

Recovery Criteria for the Mariana Crow

The following criteria are taken from the Draft Revised Recovery Plan for the Mariana Crow (USFWS 2005a).

1. The Mariana crow may be considered for downlisting from endangered to threatened status when all of the following criteria are met:

a. Mariana crow occur in two populations, one on Rota consisting of a minimum of 75 territorial pairs, and 1 in northern Guam consisting of a minimum of 75 territorial pairs;
b. Both populations are stable or increasing based on quantitative surveys or demographic monitoring that demonstrates an average intrinsic growth rate (λ) not less than 1.0 over a period of at least 10 consecutive years;
c. Sufficient Mariana crow habitat, based on quantitative estimates of territory and home range size, is protected and managed to achieve criteria 1 and 2 above;
d. Brown treesnakes and other introduced predators found to be a threat to Mariana crow are controlled at a sufficient level to achieve criteria 1 and 2 above;
e. Brown treesnake interdiction efforts are in place to prevent the establishment of brown treesnakes on Rota; and
f. Efforts to resolve Mariana crow and landowner conflicts have been implemented.

2. The Mariana crow may be removed from the Federal list of threatened and endangered species when all of the following criteria are met:
    a. Mariana crow occur in three populations, one on Rota consisting of a minimum of 75 territorial pairs, one on northern Guam consisting of a minimum of 75 territorial pairs, and one in southern Guam consisting of a minimum of 75 territorial pairs;
    b. All three populations are stable or increasing based on quantitative surveys or demographic monitoring that demonstrates an average intrinsic growth rate (λ) not less than 1.0 over a period of at least 10 consecutive years;
    c. Sufficient Mariana crow habitat, based on quantitative estimates of territory and home range size, is protected and managed to achieve criteria 1 and 2 above;
    d. Brown treesnakes and other introduced predators are controlled at a sufficient level to achieve criteria 1 and 2 above;
    e. Brown treesnake interdiction efforts are in place to prevent the establishment of brown treesnakes on Rota;
    f. Efforts to resolve Mariana crow and landowner conflicts have been implemented; and
    g. A monitoring plan has been developed and is ready for implementation, to cover a minimum of five years post-delisting, to ensure the ongoing recovery of the species and the continuing effectiveness of management actions.

Since the draft revised recovery plan was published in 2005, additional work on population viability of the Mariana crow has occurred. This recent assessment of population viability indicated that 75 territorial breeding pairs may not be viable over the long-term due to potential inbreeding depression (O'Grady et al. 2006) and projected increases in tropical storm intensity, duration, and frequency (Emanuel et al. 2008) and that 100 territorial breeding pairs may be a more appropriate recovery target (Amidon 2012, unpubl. data).Therefore, the Service now considers 100 territorial breeding pairs as our recovery target for each of the three regions identified above.

Survival and Recovery Needs on Rota

Management and recovery actions that have occurred in the last five years (USFWS 2014b, pp. 3-4) include:

- Banding: The University of Washington's Rota Avian Behavioral Ecology Program (RABEP) has banded 80 Mariana crows since 2005 (Ha et al. 2013 pp. 5-6; Kroner 2014, p. 3). Re-sight data has been used to develop age-specific survivorship models.
- Nest monitoring: RABEP have conducted nest monitoring for the Mariana crow on Rota since 2005. Efforts provide data that is used for analyses of nesting success and demographics.
- Mariana crow mortality monitoring: From 2009 to 2013, transmitters were attached by RABEP to 32 Mariana crows that were tracked and monitored for the life of the battery (n=14), until death of the bird (n=12), loss of the signal (n=1), or until the harness was removed (n=5) (Ha et al. 2013, pp. 5-6).
- Habitat and natural process management and restoration: The Mariana Crow Conservation Area (MCCA) was established on Rota through an MOA between the Commonwealth of the Northern Mariana Islands (CNMI) and PIFWO (USFWS 2011, pp. 1-4).
- Human interaction monitoring and management: The Mariana Crow Incentive Plan (2012-2014) compensated participants on Rota with a monetary award in exchange for protecting occupied crow habitat and allowing access for population monitoring and feral cat control on their land (USFWS 2012a, pp. 1-8). The goal of the plan was to change human perceptions of the Mariana crow and protect valuable habitat.
- Predator monitoring and control: The University of Washington Rota Island Feral Cat Removal Project began cat removal efforts on Rota in February 2012 (Ha et al. 2013, p. 49). As of June 2014, the project removed 589 cats from areas in and around crow territories (Leo 2014, p. 3). The Institute for Wildlife Studies took over cat control efforts on Rota in October 2014.
- Captive care: Captive care of sick or injured crows is conducted on an as-needed basis by RABEP captive care specialists.
- Release of rehabilitated crows: Crows are released into the wild after they have been rehabilitated and reared to at least 2 years of age. Two crows were successfully released after being taken in as fledglings and reared to adulthood in captivity (Hannon 2014, pp. 1-3).
- Strategic planning / threats management planning: The Service in cooperation with the Mariana Crow Recovery Team conducted an exercise in structured decision making (SDM) to determine which actions should be taken now and over the next several years to maximize the probability of preventing extinction and set the foundation for at least one stable to increasing population in the wild (see below). The two primary objectives driving the SDM were to prevent the extinction of the Mariana crow and to ensure a viable stable or increasing population in the wild.

Recovery actions still needed to prevent the extinction of the Mariana crow on Rota:

- Implement priority actions identified in the Mariana crow SDM exercise:
    - Predator control on Rota
    - Phased approach to captive propagation, beginning with rear and release program

- Identify and manage sources of adult and juvenile mortality
- Improve public perception of the crow to reduce potential human persecution
- Protect important habitat on Rota and Guam
- Research and reduce the threat of the brown treesnake on Rota and Guam

Survival and Recovery Needs on Guam

Management and recovery actions that have occurred in the last five years include:

- Construction of a 312-ac (112-ha) ungulate exclosure fence at Northwest Field on AAFB by DoD per a Biological Opinion (USFWS 2006b). However, the DON has proposed to build the proposed LFTRC within this mitigation site, which is also located on Overlay Refuge.
- Construction of the 136-ac (55-ha) Habitat Management Unit (HMU) brown treesnake and ungulate exclosure fence at AAFB. Ungulate removal within the HMU is near completion by DoD per a section 7 consultation (USFWS 2006c).
- Construction of a multi-species exclosure fence within the fee simple portion of the GNWR at Ritidian Point.
- Construction of 4,400 ft of coated chain link fence along Route 2A on the perimeter of NBG by DoD per Biological Opinion requirements (USFWS 2010a). The fence provides an ungulate exclosure for the 3,114 ac (1,260 ha) of the main base of NBG. The fencing project is intended to effectively close off Orote peninsula from any new ungulate incursions and only entry control gates will be left unfenced. Ungulate removal within NBG is ongoing.
- In 2014, the USDA-APHIS Wildlife Services, in coordination with the National Wildlife Research Center, the DoD-Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs, conducted a test of aerial application of a brown treesnake toxicant (acetaminophen) over forested areas in AAFB (Dorr et al. 2014, unpublished data). The results of this study within the approximately 136-acre (55-hectare) HMU on AAFB may result in the reduction of snake numbers to a low enough level to allow kingfishers to survive and reproduce within this snake-proofed area on Guam. The knowledge gained from this study will help with potential future improvements to the method and efficiency of the delivery of the acetaminophen to snakes on Guam.

Recovery actions still needed to allow the reintroduction of the Mariana crow to Guam

- Development and implementation of large-scale, long-term methods for brown treesnake control that will reduce the brown treesnake population on a landscape level.
- Protection and restoration of Mariana crow habitat in northern and southern Guam including in-perpetuity protection as conservation areas and fencing to exclude brown treesnakes and ungulates.
- Continued management of the fenced exclosures at Northwest Field, the HMU, and NBG as described above.

Status of the Guam Rail

Legal Status

The Guam rail (*Gallirallus owstoni*; ko'ko' in Chamorro; hereafter, rail) was listed as endangered on Guam in 1984 (USFWS 1984, pp. 2485-2488). An experimental, nonessential population of rails occurs on Rota. The rails on Rota are treated as threatened species, rather than as endangered species, for the purposes of sections 4(d) and 9 of the ESA (USFWS 1989, pp. 43966-43970). Critical habitat for the rail has not been designated on Guam.

Species Description and Current Known Range

The Guam rail is endemic to the island of Guam in the Mariana Islands. The species is derived from the closely related barred rail (*Gallirallus torquatus*) of the Philippines and Indonesia (Ripley 1977). No closely related species occur in Micronesia. The rail is medium-sized and capable of short burst of flight (1 to 2 m), but is seldom observed in flight (Jenkins 1979, p. 404). Rails are about 28 cm (11 in) in total length (Taylor 1998, p. 258). Guam rails have elongated and laterally compressed, particularly in the neck and breast regions, bodies allowing the birds to move rapidly through dense vegetation.

The rail is extirpated in the wild on Guam but persists in captivity at the Guam DAWR facility and twelve U.S. mainland zoos (AZA 2014, p. 1). Efforts to establish a nonessential experimental population on the island of Rota has been underway since 1989. The establishment of a wild population on Rota will ensure that a source wild population is available for future repatriation of rails to Guam when brown treesnakes have been controlled or eradicated on Guam (USFWS 1989, p. 43967). On Cocos Island (a small islet approximately 1.6 km (1 mi) off the southern coast of Guam), breeding pairs of rails have become established in a predator-controlled habitat through efforts associated with a Safe Harbor Agreement and activities permitted under section 10(a)(1)(A) of the ESA (USFWS 2008b; USFWS 2008c, p. 1-2). This agreement, signed in 2008, has allowed for the establishment of Guam rails on private land owned and managed by Cocos Island Resort and public land owned by the Government of Guam and managed by the Guam Department of Parks and Recreation. The rails are monitored to learn more about survivorship, breeding behavior, habitat preference and nesting success.

Life History

The Guam rail formally occurred in most habitat types on Guam, including forest, savanna, secondary grassland, agricultural areas, mown grass bordering scrub communities, mixed woodland and scrub, and fern thickets (Jenkins 1979, p. 405-406; Taylor 1998, p. 259). Guam rails were predominantly observed using scrubby secondary growth area and the edges of mixed forest areas (Jenkins 1979, Engbring and Ramsey 1984). Jenkins (1979) reports that they were seldom observed in the interior of mature limestone forests or savanna areas and did not occur in wetlands. As Guam was probably mostly limestone forest before the arrival of humans (Forsberg 1960), the rail may have become more common after much of the mature forest had been converted to scrubby second-grown or mixed forest (Engbring and Ramsey 1984).

The diet of the Guam rail is comprised of snails, slugs, lizards, insects, and vegetable matter such as seeds and palm leaves; the rail feeds on food items from the surface of the ground, especially snails and slugs after rain showers (Jenkins 1979, pp. 405-406). They chase low-flying insects and feed on seeds and flowers from low grasses and shrubs, stretching up to reach items 40 cm above the ground. They often forage along edge habitat but seldom venture far from cover (Jenkins 1979, p. 404; Taylor 1998, p. 259). During the dry season the rails were reported to damage crops such as tomatoes, cucumbers and melons, but such damage probably resulted from their obtaining moisture rather than food. Rails also ingest coral chips and pieces of small shell for grit (Jenkins 1979, p. 405-406). They are able to forage at night, but are most active during the dawn and dusk (Jenkins 1979, p. 404-406; Taylor 1998, p. 259).

Guam rails are monogamous and breed throughout the year (Jenkins 1979, p. 406; USFWS 1990a, p. 9), with a possible peak breeding period during the rainy season (May-October) (Perez 1969 as cited in the USFWS 1990a, p. 9). They can lay two to four eggs per clutch and both parents share in the construction of the nest. Nests are located on dry ground in dense grass, are a shallow cup of interwoven loose and rooted grass, and are built by both sexes (Jenkins 1979, p. 406; Taylor 1998, p. 260). Incubation of eggs is 21 days (Beck 1985, unpubl. data cited in USFWS 1990a, p. 9) with both sexes sharing the nesting duties. The eggs hatch asynchronously, and the young are precocial, leaving their nests within 24 hours of hatching to forage with the aid of their parents (Jenkins 1979, p. 406).

In captivity, Guam rails can live up to 17 years, while females can reach 16 years old. Median life expectancy for captive males is 9.5 years; captive female median life expectancy is slightly lower at 5.7 years (AZA 2014, p. 5). The median life expectancy of Guam rails in the wild is unknown. Both males and females can begin reproducing at approximately 5 months old. Males have bred until the age of 11, and females as old as 9 years old have successfully reproduced. Breeding in captivity is complex, as males can be extremely aggressive and have at times injured or killed females. In captivity, clutch sizes range from one to six eggs, averaging 2.1 eggs, with an incubation period of 19 days.

Population Dynamics and Status

Guam rails were once distributed throughout Guam (USFWS 1990a, p.7). They first disappeared from southern Guam in the early 1970's (Jenkins 1979). In 1981, the population was reduced to approximately 2,300 individuals and only existed in northern Guam (Engbring and Ramsey 1984, p. 28). In 1983, estimates of the population size indicated that fewer than 100 individuals remained on Guam and 22 individuals were moved to captive propagation facilities (Haig and Ballou 1995, p. 446). The rail was extirpated on Guam by 1987 (Wiles et. al. 1995, p. 38).

There have been two releases of rails on Guam since this species has been listed as endangered. In 1998, 16 rails were released in "Area 50" at AAFB in northern Guam (Beauprez and Brock 1999). A temporary brown treesnake barrier was constructed around Area 50 and snake populations in the barrier were reduced through snake control. Breeding was documented, although the small population was extirpated by predators, mainly feral cats. In 2003, a second release of 44 rails occurred in a brown treesnake-reduced area of the Munitions Storage Area on AAFB (P. Wenninger, DAWR, pers. comm. 2008). Efforts to reduce cat predation on the rails were limited due to difficulty in obtaining approval to control cats in the area. By 2008, rails no

longer were present in the Munitions Storage Area (P. Wenninger, DAWR, pers. comm. 2008; USFWS 2009b, p. 5).

On Rota, over 800 captive-bred Guam rails have been released between 1989 and 2008 in an effort to establish an experimental wild population (Witteman and Beck 1990, Beck 1991, Brock and Beck 1995, Beauprez and Brock 1996-1999a, P. Wenninger, DAWR, pers. comm. 2008). The introduction to the island of Rota, which is outside the historical range of the species, was justified because primary habitat on Guam had been altered through the establishment of the introduced, predatory brown treesnake (USFWS 1989, p. 43966). Improvements in managing the captive flock have increased the number of rails available for each release and the larger release cohorts have increased the likelihood of population establishment. Population estimates in 2002 indicated 100 rails were present on the northeast end of Rota near two release sites, Duge and Saguagaga. Based on surveys conducted in July 2013, there are approximately 125 rails on Rota (S. Medina, DAWR, pers. comm. 2013). However, released birds still suffer mortality primarily due to feral cat predation, which slows population establishment. Current release strategies include intensive cat trapping and a review and update of monitoring protocol for rails on Rota.

On Cocos Island, sixteen captive bred rails were released in November 2010. Prior to the release, rats (*Rattus* spp.) were eradicated on Cocos Island. Guam rails are successfully breeding (16 nests and 12 chicks have been observed) on Cocos Island. Sightings of unbanded adults have been documented, which suggests that chicks are surviving into adulthood (S. Medina, DAWR, pers. comm. 2013).

As of December 30, 2014, the Guam rail captive population is distributed among 14 institutions, with the Guam DAWR facility holding 116 birds and the 13 Association of Zoos and Aquariums (AZA) facilities housing 46 birds. At that time, current gene diversity was 88 percent in the DAWR facility and 83 percent at the AZA facilities (AZA 2014, p. 4). When gene diversity falls below 90 percent in a founding population, it is expected that reproduction will be compromised by, among other factors, lower hatch rates, small clutch sizes, and greater neonatal mortality (Ross et al. 2006). However, there still remains the potential to increase the gene diversity in DAWR and AZA facilities over the long term (AZA 2014, p. 6). The DAWR and AZA work cooperatively and closely coordinate on the transfer of birds to facilities, as needed, in order to manage the genetic diversity within the captive Guam rail population (AZA 2014, p. 4). These facilities also support the releases of individuals into the wild on Rota.

Threats (adapted from USFWS 2014c, p. 2-5):

- Loss or degradation of habitat –
    - Agricultural and urban development is a factor in habitat loss and degradation on Guam.
    - Nonnative snake predation. The brown treesnake continues to limit efforts to reestablish rails on Guam.
    - Cat predation. Feral cats continue to limit efforts to reestablish rails on Guam and impact the rail experimental population on Rota.
    - Rodent predation. Because rats have been eradicated and are absent from Cocos Island, there is continued efforts to prevent the reintroduction of rats to

this island. Rats can negatively impact rails by consuming eggs and preying on chicks.

- Stochastic events – Although birds in the Mariana Islands have evolved with typhoons, typhoons in concert with low population numbers, habitat loss, and behavioral and genetic consequences of captive breeding could negatively affect the recovery of the Guam rail.

Survival and Recovery Needs

Before the Guam rail is considered for downlisting from endangered to threatened, the repatriation of 1,000 birds to northern Guam and 1,000 birds to southern Guam (total = 2,000 individuals; USFWS 1990a, p. 33) would need to occur and brown treesnakes would need to be controlled on Guam (USFWS 1990a, p. 33-34). No criteria were defined for delisting. Traill et al. (2009) proposed a minimum population target of 5,000 individuals as an appropriate target for species conservation.

New management actions that have occurred in the last five years include:

- Brown treesnake eradication and control using acetaminophen, as a toxicant to the snake, is being conducted within the approximately 136-acre (55-hectare) Habitat Management Unit on AAFB. In 2014, the USDA-APHIS Wildlife Services, in coordination with the National Wildlife Research Center, the DoD-Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs, conducted a test of aerial application of a brown treesnake toxicant (acetaminophen) over forested areas in AAFB (Dorr et al. 2014, unpublished data). The results of this study indicate that development of a scalable automatic bait application system could be used in the near future for large landscape scale brown treesnake control and suppression (Dorr et al. 2014, unpublished data). The project may result in the reduction of snake numbers to a low enough level to allow for rails to survive and reproduce within this snake-proofed area on Guam.
- Management unit planning – On Guam, a management plan, funded by DoD, is currently being developed for the HMU on AAFB. The plan will consider the reintroduction of Guam rails to this site.
- Predator control – Cat control is conducted on Rota and will continue with increased efforts from additional funding by the Service in fiscal year 2015.

Recommendations for Future Actions (adapted from USFWS 2014c, p. 3):

- Maintain or increase genetic diversity in captive rail population – Implement management strategies to exploit the potential gene diversity in the captive populations at the DAWR and AZA facilities.
- Predator monitoring and control
  - Continue efforts to develop and refine brown treesnake control techniques and support small-scale and large-scale control and/or eradication efforts on Guam.
  - Continue and increase efforts to control and eradicate brown treesnakes on Guam and prevent introduction of brown treesnakes on other Mariana Islands.
  - Implement large-scale cat control and/or eradication.
- Reintroduction / translocation

  - Consider alternative sites for establishing other experimental populations.
  - Develop reintroduction plan for Guam rails on Guam and set aside and protect recovery areas for these rails on Guam.
- Revise recovery objectives and criteria – Revise recovery plan.
- Population monitoring and viability analysis – Continue population and demographic monitoring on Rota and Cocos Island.
- Protection and restoration of Guam rail recovery habitat including in-perpetuity protection as conservation areas and fencing to exclude brown treesnakes and ungulates.

Status of the Mariana Fruit Bat

Legal Status

The Mariana fruit bat (*Pteropus mariannus mariannus*; "fanihi" in Chamorro; hereafter, fruit bat) was listed as endangered on Guam in 1984, but was downlisted to threatened in 2005 when it was determined that all fruit bats on Guam and throughout the Commonwealth of the Northern Mariana Islands (CNMI) comprise a single subspecies (USFWS 2005b, p. 1191). In 2004 critical habitat for the fruit bat was designated at the Guam National Wildlife Refuge Ritidian Unit (USFWS 2004, p. 62944).

Species Description

The Mariana fruit bat is a medium-sized fruit bat in the family *Pteropodidae* that weighs 0.66 to 1.15 pounds. Males are slightly larger than females. The underside (abdomen) is black to brown with gray hair interspersed that creates a grizzled appearance. The shoulders (mantle) and sides of the neck are bright golden brown, but may be paler in some individuals. The head varies from brown to dark brown. The well-formed, rounded ears and large eyes give the face a canine appearance.

Current Known Range

The Mariana fruit bat is a subspecies endemic to the Mariana archipelago (Guam and the CNMI), where it was historically present on every island except Uracas (Wiles et al. 1989, p. 69). The fruit bat is thought to be extirpated from Tinian (USFWS 2009c, pp. 269-272; USFWS 2014d, pp. 2-3).

Life History

The diet of the fruit bat is comprised of fruits, nectar, pollen, and some leaves (Wiles and Fujita 1992, pp. 26-31; Wiles and Johnson 2004, p. 591), and it uses several forest types for foraging, roosting, and breeding, including native primary and secondary limestone forest, volcanic (or ravine) forest, old coconut plantations, and groves of *Casuarina equisetifolia* (Glass and Taisacan 1988, pp. 6–13; Worthington et al. 2001, pp. 137–138; Wiles and Johnson 2004, pp. 589–591). Most fruit bats roost during the day in maternity colonies at sites to which they show a high level of fidelity (unless disturbed). A small proportion of fruit bats, usually males, roost alone or in small groups called bachelor colonies. Fruit bats will abandon roost sites if disturbed and have been reported to move to new locations as far as 10 kilometers (km) (or 6 miles) away

(USFWS 1990b, p. 9). Any fruit bat colony can be disturbed by humans close enough to be smelled; which can be up to 200 m (656 ft) away (J. Boland, pers. obs. 2009). In addition, fruit bats have flushed from maternal roosts in response to aircraft overflights on Guam with noise levels above 90 dB (SWCA 2012, p. 23, 37). When colonies are disturbed, fruit bats may be negatively affected in a variety of ways, including but not limited to, destruction of social structures, direct injury, disruption of energetic and hormonal balance, forced relocation to lower quality habitat, abandonment of non-volant young, and disruption of breeding activities (Wingfield et al. 1998, pp. 191-204; Heideman 2000, pp. 469-499; Klose et al. 2006, p. 341; CNMI 2010, p. 7).

Within colonies, fruit bats typically group themselves into harems (one male and 2-15 females) or bachelor groups (predominantly males; Wiles 1987a, pp. 93-94; J. Boland, unpubl. data). Unlike most Pteropus species, mating and the presence of nursing young have been observed in Mariana fruit bats throughout the year on Guam and Rota (Wiles 1987a, pp. 93-94; CNMI 2010, p. 12; CNMI 2011, p. 12; J. Boland, unpubl. data). Data is limited for age of sexual maturity, reproductive rates, length of gestation, and lifespan of Mariana fruit bats. Female bats of the family Pteropodidae generally have a gestation period of 4.6- 6.3 months and one offspring per year (Pierson and Rainey 1992, pp. 1-17). Many Pteropus species typically do not give birth before 18 months of age (Pierson and Rainey 1992, pp. 1-17; McIlwee and Martin 2002, p. 76). Based on these reproductive traits, several authors have suggested that Pteropus bats have a low maximum population growth rate and thus a slow rate of recovery when a population is diminished (Pierson and Rainey 1992, p. 1-17; McIlwee and Martin 2002, p. 76).

Population Dynamics and Status

The total population of the Mariana fruit bat is estimated to be approximately 6,000 animals (USGS 2010, p. 36; CNMI 2011, p. 6). Surveys suggest populations are stable or declining throughout most of their range (Table 5). A notable exception to the declining trend is the island of Rota, where the population has increased since 2008 (CNMI 2008, p. 11; CNMI 2011, p. 6). The population increase on Rota is due to a recent decrease in illegal hunting at roost sites of fruit bat maternity colonies, and the decrease in illegal hunting can be attributed to an increase in enforcement of wildlife regulations that began in 2009 (CNMI 2010, pp. 7-9).

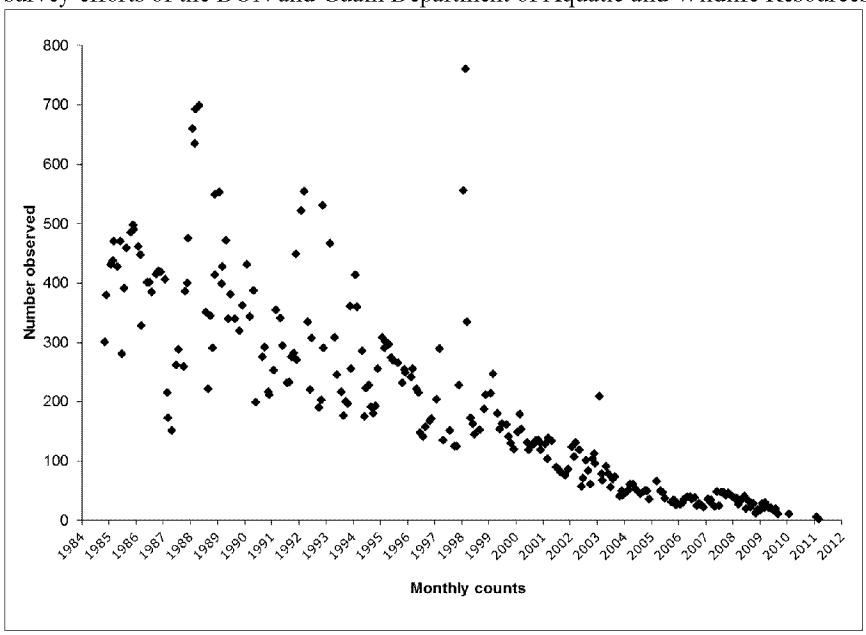
The fruit bat population on Rota is estimated at approximately 2,600 (CNMI 2011; p. 6). Although comprehensive surveys have not been conducted on Saipan, there have been no confirmed observations of maternity colonies in recent years, and the island-wide population is expected to be less than 50 individuals (T. Willsey, CNMI DLNR, pers. comm. 2014). The population of fruit bats on Guam have been estimated to be less than 30 bats (SWCA 2013, pp. 19-22; DON 2013b, pp. 11-15, DON 2014c). The last maternal colony to exist on Guam was at Pati Point (SWCA 2013, pp. 13). However, in December 2015, bats were observed within HMU on Guam. Preliminary estimates were 30 to 50 bats present within the HMU (D. Lujan, AAFB, pers. comm. 2016). Additional surveys were conducted by AAFB from December through February and on February 10, 2016, two female bats were observed within the HMU (T. Mildenstein and D. Lujan, AAFB, pers. comm. 2016). It is estimated that 112 bats are present within the HMU (T. Mildenstein, AAFB, pers. comm. 2016).

Table 5. Summary of population estimates for the Mariana fruit bat throughout the Mariana archipelago from 1983-2010 (USFWS 2014d, p. 2).

Island	**Area square mile (square kilometer)**	**Estimated minimum number of bats 1983-1984**[1]	**Estimated number of bats 2000**[2]	**Estimated number of bats 2008**[3]	**Maximum number of bats counted 2010**[4]
Maug	0.8 (2.0)	< 25	not surveyed	not surveyed	11
Asuncion	2.9 (7.4)	400	not surveyed	not surveyed	573
Agrihan	18.3 (47.4)	1,000	1,000	not surveyed	858
Pagan	18.4 (47.7)	2,500	1,500	not surveyed	1,017
Alamagan	4.3 (11.0)	0[5]	200	not surveyed	86
Guguan	1.5 (4.0)	400	350	not surveyed	226
Sarigan	1.9 (5.0)	125	200	not surveyed	157
Anatahan	12.5 (32.3)	3,000	1,000	not surveyed	150
Saipan	47.5 (122.9)	< 50	not surveyed	not surveyed	not surveyed
Tinian	39.3 (101.8)	< 25	not surveyed	0	not surveyed
Aguiguan	2.7 (7.0)	< 10	150-200	40-60	not surveyed
Rota	32.9 (85.2)	800-1,000	not surveyed	1019[6]	2,283[8]
Guam	212 (549.0)	425-500	119-179	<40[7]	not surveyed

[1] Wiles *et al.* 1989. Count methods: Evening dispersal counts at colonies and evening station counts of solitary fruit bats. All counts considered to be minimum estimates.
[2] Cruz *et al.* 2000a-f. Count methods: Evening dispersal counts at colonies, evening and morning station counts of solitary fruit bats. Data for Guam represents the range of 10 counts conducted in a separate effort in 2000 (A. Brooke pers. comm. 2007 *in* USFWS 2009d).
[3] Data for Tinian and Aguiguan from USFWS (2008). Data for Rota from CNMI (2008).
[4] Data for Northern Islands from USGS (2010). Data for Rota from CNMI (2010).
[5] Alamagan was inadequately surveyed in 1983 and may have held some fruit bats.
[6] Direct counts at all maternity colonies plus departure counts at extra-colonial sites in July 2008
[7] Brooke (2008) and SWCA (2013)
[8] Direct counts for all maternity colonies in May 2010 plus departure/arrival counts at extra-colonial sites in April 2010

Figure 5. Direct counts of fruit bats at the historical fruit bat maternity colony at Pati Point on Andersen Air Force Base from 1984-2011 (A. Brooke, pers. comm. 2014, data compiled from survey efforts of the DON and Guam Department of Aquatic and Wildlife Resources).



Threats (adapted from USFWS 2014d, pp. 4-5):

- Loss or degradation of habitat:
  - Human development is a factor in habitat loss on all inhabited southern islands and on northern islands with military activity.
  - Feral ungulates and Philippine sambar deer (*Rusa marianna*) degrade habitat on many of the Mariana Islands. The successful eradication of feral ungulates from Sarigan and Anatahan suggests that similar projects may succeed on other islands. However, once grazing and browsing pressure is removed, the potential invasion of native forest by alien plants may be a more difficult and long-term recovery issue.
- Human disturbance:
  - Illegal hunting is a threat to Mariana fruit bats throughout its range. Although law enforcement activity has increased since 2009 (CNMI 2008, 2009a-b, 2010), illegal hunting of fruit bats on Rota continues and will likely resume to historical levels unless consistent, effective law enforcement efforts in tandem with education and outreach programs continue. Fruit bats appear to be extirpated from Tinian and are declining on Saipan and Guam, and illegal hunting is thought to have greatly contributed to the decimation/decline of those populations (Wiles and Payne 1986; Wiles and Glass 1990; Sheeline 1991; Stinson et al. 1992; Wiles 1992; Esselstyn et al. 2006). As with Rota, recovery of the fruit bat on human-inhabited islands will not likely be possible without strong education programs combined with effective control of illegal hunting.

- Nonnative snake predation –Brown treesnakes prey on non-volant young left at the roost during the night, thus preventing the recruitment of young bats into the breeding population. Effective control of brown treesnakes must be achieved before fruit bat population on Guam can recover. The interdiction, control, and ultimate eradication of brown treesnakes in the archipelago are the focus of major, ongoing projects, and the fruit bat is likely to benefit from these efforts in the long term. This prognosis would change drastically if the brown treesnake were to become established widely throughout the archipelago.
- Stochastic events – Typhoons and volcanic eruptions result in mortality, reduced population viability, and habitat loss. Natural disasters can be especially damaging to the viability of smaller fruit bat populations (*e.g.*, on Guam, Saipan, Aguiguan, and Maug). The significant loss of habitat on Anatahan after the volcanic eruption in 2003 resulted in the loss of a substantial fruit bat population that has not yet recovered.

Survival and Recovery Needs

Before the Mariana fruit bat is considered for delisting, the Service proposes that stable or increasing populations should exist on three of the five southern islands (Saipan, Tinian, Aguiguan, Rota, and Guam), and six of the northern islands where Mariana fruit bats have persisted historically (Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, and Maug; USFWS 2009d, pp. 37-39). Of the six northern islands that require stable or increasing fruit bat numbers, two of these must include Pagan, Anatahan, or Agrihan. Since publication of the draft revised recovery plan in 2009, new information on the Mariana fruit bat has resulted in changes to how we look at recovery for the species. We now consider recovery in terms of stable or increasing subpopulations of sufficient size distributed across Guam and the Mariana Islands. To meet recovery objectives, stable or increasing fruit bat subpopulations should at a minimum be distributed on the islands that currently have extant populations (USFWS *in review*). The final version of the Mariana fruit bat recovery plan is currently in review, and recovery criteria stated here may change upon completion of the final plan

Of the six northern islands, the only evidence for a possibly increasing population is on Asuncion (USGS 2010, p. 33). Of the five southern islands, only Rota has achieved an increasing population. Although a conservation area containing some important habitat for fruit bats was established on Rota (USFWS 2011, pp. 1), there is not currently enough protected fruit bat habitat on Rota, Guam, Tinian, or Saipan to support substantial population recovery on any of those islands. Even if sufficient habitat is set aside in conservation to support recovery of populations, controlling illegal hunting may continue to be a challenge that limits recovery of the species.

New management actions (adapted from USFWS 2014d, pp. 4-5):

- Monitoring and analysis of population viability – Technical assistance was obtained in 2008 to analyze fruit bat survey data from Rota and refine survey methods and the existing monitoring program (CNMI 2008, 2009a-b, 2010).
- Law enforcement and compliance – On the island of Rota, the Service and the CNMI Division of Fish and Wildlife (DFW) have increased law enforcement actions since 2009. With support from Service law enforcement and federal discretionary funds, CNMI Conservation Officers have participated in nine fruit bat-related arrests on Rota, all

resulting in convictions. Enforcement actions have contributed to a decrease in illegal hunting, and approximate doubling of the fruit bat population on Rota.

- Development of monitoring protocol – Experts were consulted to review and refine survey methods for fruit bats to develop standardized, quantitative monitoring that permits data comparison at multiple timescales. Standard operating procedures were developed for CNMI DFW (CNMI 2009a) and a monitoring protocol was developed for Service for fruit bat surveys in the Northern Mariana Islands (Mildenstein and Boland 2010).
- Surveys / inventories – Surveys were conducted on Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, and Maug in 2010 (USGS 2010). A base-wide survey was conducted on AAFB in 2014 (DON 2014c).
- Habitat and natural process management and restoration – The Mariana Crow Conservation Area was established on Rota through an MOA between the CNMI and the Service (USFWS 2011). This area encompasses 444 hectares (1097 acres) and contains some high-quality foraging and roosting habitat for fruit bats.
- Outreach and education – Discussions were initiated with CNMI DFW and CNMI Public School System (PSS) to develop outreach and education materials and opportunities to curb illegal hunting. Several education and outreach programs were funded by the Service, Bat Conservation International, Disney, and Lubee Bat Conservancy, and these programs were implemented on Rota through a local non-profit. An education curriculum was developed with the CNMI PSS, but has not yet been implemented.

Recommendations for Future Actions (adapted from USFWS 2014d, pp. 5-6):

- Outreach and education – Decrease illegal hunting by developing and supporting outreach and education programs that emphasize the value of and need to protect fruit bats and other native plant and wildlife species in the Marianas.
- Law enforcement and compliance – Decrease illegal hunting by continuing to provide technical and financial assistance to CNMI DFW enforcement officers to facilitate apprehension and prosecution of poachers.
- Ungulate monitoring and control
    - Decrease habitat loss by eradicating feral ungulates on islands where they exist, and preventing their introduction on other islands where fruit bat recovery is desired.
    - Decrease habitat loss by controlling deer in areas of high-quality fruit bat habitat.
- Habitat and natural process management and restoration
    - Improve habitat through support of native forest restoration, especially on Guam, Saipan, and Tinian.
    - Set aside enough high-quality habitat including in-perpetuity protection of conservation areas to support the recovery of fruit bat populations on three of the five southern islands.
- Human interaction monitoring and management
    - Limit military training in areas occupied by fruit bats to activities that will not disturb fruit bats or their habitat.
    - Limit urban development in areas occupied by or potentially used for roosting and foraging by fruit bats.

- Population monitoring and viability analysis – Continue monitoring fruit bat numbers on Anatahan to understand the fluctuation of numbers in response to volcanic activity.
- Population monitoring and viability analysis – Hire and ensure consistent employment of a full-time, resident DFW or Service biologist who is charged with monitoring the fruit bat population on Rota according to established protocols (CNMI 2009a, Appendix 1).
- Predator / herbivore monitoring and control
    - Development and implementation of large-scale, long-term methods for brown treesnake control that will reduce the brown treesnake population on a landscape level on Guam.
    - Continue and increase efforts to prevent introduction of brown treesnakes on other Mariana Islands.

Status of *Serianthes nelsonii*

Legal Status

Serianthes nelsonii, "hayun lågu" or "tronkon guafi" in Chamorro was listed as endangered in 1987 (USFWS 1994, p. 1). No critical habitat has been designated for this species.

Species Description and Current Known Range

Serianthes nelsonii is a large tree in the pea family (Fabaceae, subfamily Mimosoideae). Adult trees can reach heights over 30 m (98 ft) and diameters over 1.5 m (4 ft) (USFWS 1994, p. 11). Its bark is smooth and light brown in color. Fine rusty hairs cover the flowers, seed pods, and newer vegetation growth. Leaves are doubly pinnate with many pairs of leaflets. Flowers are brush-like with pink and white coloration, and fruits are hard, dry, brown pods (Stone 1970, p. 304). Seedlings closely resemble those of a small introduced tree, *Leucaena leucocephala* (tangantangan), but can be discerned by the fine pubescence on new leaf buds (USFWS 1994, p. 6).

Serianthes nelsonii is endemic to the islands of Guam and Rota (USFWS 1987, p. 4907). Recorded specimens on Guam were mostly from northern limestone forests, but a few trees were recorded in southern clay soils (USFWS 1994, p. 8). Currently, the last remaining wild adult tree on Guam is located at NWF, AAFB in northern Guam. A new fence was constructed to exclude ungulates in 2012 by AAFB, the *Serianthes* tree and seedlings are monitored monthly by DoD. DoD has conducted research on limiting factors for seedlings, fallen seeds collected and stored for future use. In 2014, 31 *S. nelsonii* seedlings supplied to the Service by JRM were planted at the GNWR in northern Guam (Demeulenaere et al. 2015, p. 4). The 31 seedlings are maintained with 2 previously outplanted saplings on the GNWR. On AAFB, one outplanted sapling is located in the Tarague Basin.

The history of *S. nelsonii*'s abundance and distribution on Rota is poorly known (USFWS 1994, p. 7), but surveys in 1994 estimated 121 adult trees with very little regeneration (Wiles et al. 1996, p. 232). Current estimates for Rota are 40 to 50 wild adult trees with little to no regeneration (J. Manglona, CNMI DLNR, pers. comm. 2015).

Life History and Ecology

Serianthes nelsonii is recorded mainly from limestone soils, with a few historical occurrences in clay soils in Guam (USFWS 1994, p. 8). Most of the adult trees in Rota occur on or near steep limestone cliffsides, and the last wild adult tree in Guam is located in rugged limestone karst habitat at NWF. What little is known about pollination, seed dispersal, phenology, flowering, and fruiting for this species comes mainly from incidental reports (USFWS 1994, p. 11). Fruiting occurs throughout the year, as seed pods have been observed during all months of the year (USFWS 1994, pp. 11-13). Similarly, flowering has been recorded during all months of the year, with one report (Schreiner and Nafus 1991, as cited in USFWS 1994, p. 11) reporting the highest proportion of branches with flowers in May and June. This report also indicated leaf production throughout the year with declines during the dry season from January to June. Age of reproduction in the wild is also unknown, but flowers and pods have been observed on cultivated trees as young as 10 years old (USFWS 1994, p. 13).

Serianthes nelsonii, being a large, canopy tree species, provides habitat for a number of smaller species. This species supports a diverse community of arthropods including predator species such as spiders and mantids that may control other potentially problematic insect populations (Wiles et al. 1996, p. 233). *S. nelsonii* also hosts a variety of epiphytes including ferns, orchids, and other plants such as *Ficus* sp., and *Freycinetia reineckei* (Wiles et al. 1996, p. 233-234).

Population Dynamics and Status

The total wild population of *Serianthes nelsonii* is estimated to be 50 adult trees, with almost all of the population occurring in Rota, and a single wild adult tree in Guam. In addition, there are outplanted occurrences on each island, all younger than 20 years of age. Seedling propagation and outplanting on Rota have been ongoing with limited success over the past 20 years, mainly in the Isang area in southern Rota, and between the main villages of Songsong and Sinapalo. Approximately 10 outplanted individuals in Rota have survived to a reproductive age (J. Manglona, CNMI DLNR, pers. comm. 2015). Twenty seedlings were outplanted in 1999 in the Tarague Basin, on AAFB in Guam (M. Marutani, University of Guam, pers. comm. 2015). To date, only one of these saplings has survived (AAFB 2015), but has not produced any seed pods (A. Gawel, USFWS, pers. obs. 2014). In 2009, approximately 30 seedlings were planted at the GNWR; all but 5 have survived (J. Cruce, USFWS, pers. comm. 2015). In 2014, 31 seedlings were donated to GNWR by JRM and outplanted and are being maintained by the Guam Plant Extinction Prevention Program (Demeulenaere 2015, p. 4) and GNWR staff.

Recent *Serianthes nelsonii* recovery efforts on Guam and Rota have been dependent on funding, the amount of available propagated seedlings in nurseries, and the seedling to adult survival rates in the wild. In early 2015, the total number of nursery seedlings and saplings in Guam and Rota was estimated at 300 individuals, with approximately 200 in Guam nurseries. However, this estimation may change rapidly if outplanting seedling survival is low. Recent studies from AAFB indicated that although many seeds fall from the Guam adult tree and many of the seeds germinate, there is very limited survival under the mother tree (AAFB 2015). Both islands' populations have constant regeneration of wild seedlings that are several days to several months old. However, these seedlings experience incredibly high turn-over, and in recent decades, none have been known to survive to adulthood in the wild (J. Manglona, CNMI DLNR, pers. comm.

2015; AAFB 2015, pp. 4-5). Although wild seedling survival is bleak, progress has been made on increasing the likelihood of survival of outplanted individuals with new methods of insect control and exclusion, given insect herbivory and damage are the major cause of outplanted seedling early mortality (E. Demeulenare, GPEPP, pers. comm. 2015).

Threats (adapted from USFWS 2012b, pp. 10-14):

- Loss and degradation of habitat – Development from construction and military training has decreased the total recovery habitat for this species. *Serianthes nelsonii* habitat continues to be degraded by ungulates (Wiles et al. 1996, p. 234; DON 2013c), i.e. feral pigs and Philippine deer (*Rusa mariannae*), and by encroachment of invasive plants. In addition, declines in pollinators, seed dispersers, and insectivores have contributed to habitat loss (Wiles et al. 1996 p. 230).
- Introduced predators and herbivores – Introduced deer and pigs feed on *Serianthes nelsonii* (Wiles et al. 1996, p.234; Morton et al. 2000, p. 230). A number of invertebrate predators and herbivores also have been reported on this species: mealybugs (*Dysmococcus brevipes*, *D. neobrevipes*, *Ferrisia virgate*, and *Planococcus* sp.), caterpillars of *Eurema blanda*, termites (USFWS 2012b), and katydids (A. Moore, University of Guam, pers. comm. 2014). In addition, insect predation occurs on seed pods in Rota, but the insect is unknown (USFWS 2012b).
- Stochastic events – Typhoons have resulted in damage and mortality to this species as well as damage to habitat (USFWS 2012b).

Survival and Recovery Needs

For *Serianthes nelsonii* to be considered for delisting, the Service proposes that at least four populations be established on each island – Guam and Rota – each with a 10-year average of 500 or more reproductive plants (USFWS 1994, p. 26). The populations should have age structures comprised of a large proportion of adult trees as well as seedlings and immature trees (USFWS 1994, p. 26). In addition, the Service recommends that the populations on Rota be separated by at least 1 km (0.621 mi), and that at least one of the populations in Guam should be in the southern part of the island (USFWS 1994, p. 26).

To achieve recovery needs, the Service outlines the following recovery actions (adapted from USFWS 1994, pp. 27-37):

- Additional surveys are needed on both islands since the last surveys for this tree were in 1994. To prevent ungulate degradation and herbivory, subpopulations should be fenced wherever possible. Methodology to control insect pests should be developed and implemented. Existing individuals need to be monitored for survivorship, new threats, and any possible evidence of regeneration. Public education and community involvement should also be encouraged and developed.
- Conduct research important to the management of *Serianthes nelsonii*. The ecology, life history, and habitat requirements of *S. nelsonii* are poorly understood and should be studied. Although a number of insect pests have been identified, many remain unidentified, and their ecology, specific effects, abundance, and especially control methods need to be investigated. The Service also recommends genetic studies, especially on the variation between Guam and Rota populations, as well as any effects from small population size and inbreeding.

- Augment current populations and reintroduce to historical range. Plans for augmentation and reintroduction should be developed for both Guam and Rota. Areas for outplanting should be identified and secured, and plants should be propagated and transplanted to the identified areas.
- Prevent clearing of forest next to *S. nelsonii*. Maintenance of an intact forest canopy next to *S. nelsonii* will reduce the potential of edge effects and for high winds during typhoons to break tree limbs and trunks.
- Implement standardized control procedures for insect pests after research on insect control determines appropriate methodology.

New management actions that have occurred in the last five years include:
Since *Serianthes nelsonii* was listed in 1987, outplanting of individuals have been attempted with limited success. However, several recovery projects aimed at understanding and improving outplanting efforts and management of individuals have begun since 2011:

- The last remaining adult tree in Guam is fenced to prevent access by ungulates and monitored monthly for new saplings and fence maintenance (USFWS 2011, p. 3). Monitoring of seedling emergence and growth throughout the study showed 488 seedlings emerged beneath the Ritidian tree; only 4 seedlings exhibited a lifespan greater than 200 days (DON 2014).
- The Air Force has funded research to look at ecology, seedling survival, propagation methods, and health and life history of the adult tree (AAFB 2015).
- The Service has funded a project with the CNMI Division of Forestry in Rota to outplant and maintain *S. nelsonii* in fenced plots on private property.
- The Service has funded a multi-year project for *Serianthes nelsonii* recovery on the GNWR to be managed by a full-time biologist. This person will work with the Guam Plant Extinction Prevention Program to maintain the *S. nelsonii* seedlings that were outplanted at the GNWR in 2014. The Service is collaborating with Guam Department of Agriculture, DoD, the University of Guam, and the Guam Plant Extinction Prevention Program.

Comment [F5]: Get reference.

Recommendations for Future Actions (adapted from USFWS 2012b, pp. 17-18)

- Captive propagation for genetic storage and reintroduction:
    - Continue to collect seeds from all existing populations and propagate at multiple locations to increase success.
    - Perform genetic studies to determine if Guam and Rota populations are distinct.
- Captive propagation protocol development – Protect seed pods with a fine mesh covering to prevent predation by arthropods before seeds mature.
- Reintroduction / translocation implementation:
    - Propagate and maintain all outplanted individuals on the GNWR to a size where insect herbivory is less likely to cause mortality. This will likely be when plants produce multiple branches and the main stem achieves a girth sufficient enough to withstand damage from *Eurema blanda* butterflies laying eggs in the plant's tissue.
- Ungulate control – Continue to protect all populations against disturbances from feral ungulates.

- Invertebrate control research – Research and identify the effects of invertebrate predation on seeds and seedlings of *S. nelsonii.* If determined to be a limiting factor, develop and implement control measures to protect the species.
- Population biology research – Research the use of mechanical pollination to enhance outbreeding of the species.
- Surveys / inventories – Resurvey the historical range of the species to determine if previously unknown or newly reestablished populations exist.
- Threats research:
    - Research what factors are limiting the natural recruitment of individuals in Guam.
    - Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species.
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species within fenced exclosures.
- Site / area / habitat protection – Develop and implement effective measures to reduce the impacts of agricultural and urban development and hurricanes (typhoons).
- Fire protection – Develop and implement a fire management plan for all populations.
- Alliance and partnership development – Continue to work with GNWR, Guam Rare Plant Restoration Group, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species.

STATUS OF THE SPECIES

Status of *Bulbophyllum guamense*

Legal Status

Bulbophyllum guamense (or siboyas hålum tåno in Chamorro) was listed as threatened under the ESA in 2015 (USFWS 2015, 73 pp.). No critical habitat has been designated for this species. The Service has not completed a recovery plan for *B. guamense*.

Species Description and Current Known Range

Bulbophyllum guamense, an epiphyte in the orchid family (Orchidaceae), occurs in large mat-like formations high on branches of big trees as well as on smaller trees. *B. guamense* have leaves that are oblong, elliptic and 10 to 15 cm long (Stone 1970, p. 155), and flowers that are single, fleshy, and greenish-yellow in color (Raulerson and Rinehard 1992, p. 90). The sepals are the most conspicuous part of the flower, while the yellow-green lip with its wine markings is hinged and extremely mobile.

Bulbophyllum guamense is known from widely-distributed occurrences on the southern Mariana Islands of Guam and Rota, in the forest ecosystem (Ames 1914, p. 13; Raulerson and Rinehart 1992, p. 90; Costion and Lorence 2012, pp. 54, 66; Global Biodiversity Information Facility (GBIF) 2012a–*Online Herbarium Database*; Zarones et al. 2015c, in litt.). *B. guamense* was recorded historically on Guam from clifflines encircling the island, and on the slopes of Mt. Lamlam and Mt. Almagosa. In 1992, this species was reported to occur in large mat-like formations on trees "all over the island," (Guam) (Raulerson and Rinehart 1992, p. 90).

However, *B. guamense* has declined in number and populations on Guam, which represents half its known range. On Rota, *B. guamense* can occur along the Sabana tableland and slopes above 980 ft (300 m) (USFWS 2015, p. 59434).

Life History

Little is known about the life history of *Bulbophyllum guamense*. All members of the genus Bulbophyllum are epiphytes (growing on other plants), and some species are lithophytic (growing on rocks). *B. guamense* is epiphytic and grows on trees within limestone forest type ecosystems. On AAFB on Guam, this orchid can be observed in limestone forest dominated by the introduced *Vitex*, and in primary limestone forest dominated by *Arctocarpus* and *Ficus* in the lower canopy of closed forest about 10 feet or less above ground. On the Naval Magazine on Guam, this orchid is observed in humid areas in lower elevation, on Areca palms (*Dypsis* sp.) or *Pandanus tetorius* (JRM 2016, pp. 4-9). On Rota, *B. guamense* occurs within the *Hernandia-Eleocarpus* limestone forest ecosystem (USFWS 2015, p. 59434).

Typical to orchids in this genus, *Bulbophyllum guamense* has a carrion-like scent (Raulerson and Rinehard 1992, p. 90). *B. guamense* is almost ever-blooming, as one flower drops, another replaces it until one is pollinated. The ovary then enlarges to form a ribbed capsule about 5-by-1 cm, where the dust-like seeds develop (Raulerson and Rinehard 1992, p. 90). *B. guamense* has a sympodial growth habit which form sequential pseudobulbs (with determinate growth). Research is currently being conducted to determine if we could potentially increase the number of this orchid vegetatively by division within a nursery environment (J. McConnell, UOG, pers comm. 2016).

Current Status

There are approximately 844 individuals on Guam and at least 261 individuals on Rota (USFWS 2015, p. 59434; DON 2015b, Joint Region Marianas 2016). The Naval Magazine contains approximately 753 individuals, which is the majority of known individuals on Guam (Joint Region Marianas 2016). Other areas on Guam contain few individuals. Eight *B. guamense* were found during those surveys within the HMU in a limestone forest dominated by non-native *Vitex* (Naval Facilities Marianas 2016, p. 172 as cited in Army 2016). The University of Guam surveys resulted in an observation of one occurrence of *B. guamense* within the proposed northern edge of the non-standard small range of the LFTRC at the Ritidian area (DON 2015b, attachment).

On Rota, there are at least 261 individuals of *Bulbophyllum guamense* with a population structure consisting of seedlings, juveniles, and flowering adults (Zarones et al. 2015c, in litt). The number of individuals was suggested to be as high as 16,000 individuals on Rota, however this estimate is based on the assumption that *B. guamense* is uniformly distributed across its habitat (Zarones et al. 2015c, in litt).

Bulbophyllum guamense has declined in number of populations and individuals, especially on Guam which represents half of its known range. The remaining individuals are vulnerable to effects of continued habitat loss and other threats as detailed below (USFWS 2015, p. 59434).

Threats (USFWS, p. 59343; see also General Environmental section of this Opinion)

- Loss and degradation of habitat – Development from agriculture, construction, and military training has decreased the recovery habitat for this species. *B. guamense* habitat continues to be degraded by ungulates, nonnative plants, and fires.
- Predation by nonnative slugs.
- Stochastic events - Typhoons will continue to degrade forest and the affected forest areas may require several years to regenerate.
- Climate change will exacerbate many of these threats.

Survival and Recovery Needs

In order to recover and ensure the survival of *Bulbophyllum guamense*, wild populations of this species and its habitat need to be protected and maintained on Guam and Rota. The populations of *B. guamense* should have age structures consisting of seedlings, juveniles, and adult plants. The presence of large, feral ungulate populations on Guam is likely to further degrade remaining forest habitats, thus lowering their value for *B. guamense* recovery. Ungulate control needs to be implemented throughout the range of this species. Similarly, control of nonnative plants and slugs is critical for the conservation of *B. guamense*.

Management actions that have occurred in the last five years:

- For fiscal years 2014-2015, the Service funded the Guam Plant Extinction Prevention Program (GPEPP) to work on the seed germination and propagation of *B. guamense*. GPEPP is working on cultivation of *B. guamense* in their plant nursery.

- GPEPP is building a relational database and geodatabase to connect all plant handling activities. Records from the different GPEPP projects and activities will be stored in this database. The database will house ex situ (wild populations and outplanted population records) and in situ (seed storage, in vitro propagation and Rare Plant Nursery) data. This work is conducted under a U.S. Forest Service grant.

Recommendations for Future Actions:

- Monitor the status of *B. guamense*.
- Determine life history and habitat preferences.
- Identify areas that are needed to be protected for the conservation of *B. guamense*.
- Eradicate or control ungulates within *B. guamense* habitat.
- Determine the best methods in augmenting populations and relocating and/or reintroducing *B. guamense* into protected areas within its historic range.
- Prevent and treat insect infestation on trees.

Status of the *Dendrobium guamense*

Legal Status

Dendrobium guamense was listed under the ESA as threatened in 2015 (USFWS 2015, 73 pp.). No critical habitat has been designated for this species. The Service has not completed a recovery plan for *D. guamense*.

Species Description and Current Known Range

Dendrobium guamense (no common name) is an epiphyte in the orchid family (Orchidaceae). This orchid usually occurs on tree branches in forests in filtered sunlight. Stems are crowded and can be 1 meter long. Two small white flowers emerge between two leaves, and are open only one day, appearing as balls on the second day.

Dendrobium guamense occurs in the forest ecosystem on Guam, Rota, Saipan (historically), and Tinian, and recently recorded for the first time on Aguiguan (Ames 1914, p. 14; Raulerson and Rinehart 1992, p. 98; Quinata 1994, in litt.; Raulerson 2006, in litt.; Costion and Lorence 2012, p. 66; Zarones et al. 2015a, in litt.; Zarones et al. 2015c, in litt.). As recently as the 1980s, this species was common in trees on Guam and Rota, with more than 12 occurrences on Guam and 17 occurrences on Rota (Raulerson and Rinehart 1992, p. 98; Consortium Pacific Herbarium 2012a—*OnlineHerbarium Database,* 5 pp.).

Life History

Little is known about the life history of *Dendrobium guamense.* As an epiphytic orchid, *D. guamense* are supported by trunk and thick lower branches, sometimes in small twigs in the top of the canopy of trees. They cling strongly onto their hosts with developed root system and use the moisture and organic debris caught in the crevices and bark of the host for nourishment. The humid tropical air is absorbed for additional moisture and nutrients. In northern Guam, individuals of *D. guamense* were observed mostly on *Ficus proximal* about 10 to 25 ft high in the canopy (JRM 2016, p. 7). *Dendrobium* species take advantage of the microclimate, which are found on the trunk, lower branches, under the canopy, and can prefer shade or moderate light (Landscape and garden 2015, in litt). However, *D. guamense* individuals have been observed within forest edges, where there is more than moderate light (A. Gawel, Service, pers. comm. 2016). In the Naval Magazine in southern Guam, *D. guamense* was observed at all elevations along rivers and on ridges and plateaus, and on numerous tree species (JRM 2016).

Current Status

There are at least 23 occurrences totaling at least 2,690 individuals distributed on the islands of Guam, Rota, Tinian, and Aguiguan. In 2012, *D. guamense* was reported present at 4 occurrences totaling fewer than 250 individuals on Guam (Quinata et al. 1994, p. 8; Harrington et al. 2012, in litt). During surveys in 2014 to 2015 in DoD areas on Guam, *D. guamense* was observed within habitat surrounded by the Ritidian Ungulate Fence at NWF and over 1,200 were observed in the Naval Magazine (JRM 2016, pp. 4-9). In addition, 29 clumps of approximately 340 individuals are present within the Finegayan area on Guam (DON 2016c). On Rota, at least 15 occurrences of *D. guamense* are present, and a recent survey team reported more than 700 individuals of *D.*

guamense on the western third of Rota, represented by seedlings, juveniles, and flowering adults (Harrington et al. 2012, in litt; Zarones et al. 2015c, in litt.). The presence of multiple generations in a healthy population structure indicates that the status of *D. guamense* on Rota is better than previously known. There are two reported occurrences on the island of Tinian, with an unknown number of individuals (Quinata 1994, in litt.; Raulerson 2006, in litt.; CPH 2012a—*Online Herbarium Database,* 5 pp.). Zarones et al. (2015a, in litt.) discovered three individuals of *D. guamense* on the island of Aguiguan, a new island record for this species.

The populations of *D. guamense* on Guam, which comprise more than 50 percent of its known range, have declined due to threats predominantly associated with habitat destruction and modification (*i.e.*, development, military training, nonnative plants and animals, fire, typhoons, and climate change) (Harrington et al. 2012, in litt.).

Threats (adapted from USFWS 2015a, pp. 59431, 59453, 59454-5, 59457, 59459, and 59467):

- Loss or Degradation of Habitat
  - Incremental habitat loss due to wild fire, urbanization, and agricultural development is increasingly threatening the availability of habitat.
  - The ongoing and proposed expansion plans of DoD training and operations on Guam are threatening the remaining *D. guamense* habitat and potential future conservation efforts from the activities associated with the expansion.
  - As numbers of cattle and ranchers increase on Tinian, there may be a greater risk of cattle potentially escaping and becoming feral. Both feral and domestic cattle can drastically alter the landscape (Wiles et al. 1990, pp. 176–177), and depending on the location and amount of land designated as pasture land for domestic cattle, negative impacts to the forest ecosystem may be observed in the future, minimizing the available habitat.
  - The presence of nonnative plants and other nonnative ungulates (pigs, goats, and water buffalo), and Philippine deer, is likely to further degrade remaining forest habitats, thus impeding their ability to survive.

- Predation
  - Nonnative slugs have been observed to cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds), including orchids, and are considered.

- Stochastic Events
  - Typhoons will continue to degrade forest and the affected forest areas may require several years to recover.
  - On a global scale, sea level is rising as a result of thermal expansion of warming ocean water; the melting of ice sheets, glaciers, and ice caps; and the addition of water from terrestrial systems (Climate Institute 2011, in litt.). Individuals that occur close to the coast in the adjacent forest ecosystem at or near sea-level and may be negatively impacted by sea-level rise and coastal inundation due to climate change.

- Climate Change

- We anticipate the effects of climate change will further exacerbate many of the above threats in the future (USFWS 2015b, pp. 59435-6)

Survival and Recovery Needs

In order to recover *Dendrobium guamense*, individuals of this species in the wild and their habitat need to be protected on Guam, Rota, Tinian, and Aguiguan. *D. guamense* populations should have age structures consisting of seedlings, juveniles, and adult plants. The presence of large, feral ungulate populations on islands is likely to further degrade remaining forest habitats, thus lowering their value for *D. guamense* recovery. Ungulate control needs to be implemented throughout the range of this species. Similarly, control of nonnative plants and slugs is critical for their recovery.

Management actions that have occurred in the last five years:

- From fiscal years 2014-2015, the Service funded GPEPP to work on the propagation of *D. guamense*. GPEPP's mission is to prevent the extinction of Guam's rarest plant species that have fewer than 200 individuals in the wild on Guam. GPEPP works with conservation partners to protect wild populations and reintroduce plants to their natural habitat. The Service is working with GPEPP in efforts to outplant *D. guamense* within protected areas on Guam.

- GPEPP is building a relational database and geodatabase to connect all plant handling activities. Records from the different GPEPP projects and activities will be stored in this database. The database will house ex situ (wild populations and outplanted population records) and in situ (seed storage, in vitro propagation and Rare Plant Nursery) data. This work is conducted under a U.S. Forest Service grant.

- A conservation project on Rota, administered through the Water and Environmental Research Institute of the Western Pacific at the University of Guam, is aimed to analyze the island's hydrology, with the ultimate goal of protection of the Sabana Watershed and Talakhaya Springs (Keel et al. 2007, pp. 5, 22–23). Erosion control, revegetation, and water source preservation conducted as part of this project may provide protection to *D. guamense* (USFWS 2015a, p. 59460).

Recommendations for Future Actions:

- Monitor the status of *D. guamense*.
- Determine life history and habitat preferences.
- Identify areas that are needed to be protected for the conservation of *D. guamense*.
- Eradicate or control ungulates within *D. guamense* habitat.
- Determine the best methods in augmenting populations and relocating and/or reintroducing *D. guamense* into protected areas within its historic range.
- Prevent and treat insect infestation on trees.

STATUS OF THE SPECIES

Status of *Cycas micronesica*

Legal Status

Cycas micronesica (or "fadang" in Chamorro) occurring within the Mariana Islands was listed as threatened under the ESA in 2015 (USFWS 2015, 73 pp.). No critical habitat has been designated for this species. A recovery plan for *C. micronesica* has not been completed.

Species Description and Current Known Range

Cycas micronesica is a palm-like, usually unbranched tree in the Cycadaceae family (Raulerson and Rinehart 1991). Adult trees can reach heights of 6 meters and fronds can reach 1 to 2.5-m long (Stone 1970, p. 65; Raulerson and Rinehart 1991, p. 4). It is known from Guam, Rota, Tinian, and Pagan (Mariana Islands); as well as Palau (politically the independent Republic of Palau) and Yap (geographically part of the Caroline Islands; politically part of the Federated States of Micronesia, in the forest ecosystem (Hill et al. 2004, p. 280; Keppel et al. 2008, p. 1,006; Cibrian-Jaramillo et al. 2010, pp. 2,372-2,375; Marler 2013, in litt.; DON 2015x CJMT DEIS pp. 3-140).

Currently, there are 15 to 20 occurrences of *Cycas micronesica* totaling 900,000 to 950,000 individuals on the Micronesian Islands of Guam, Rota, Yap, and Palau. There are a small number of individuals on Pagan (DON CJMT BA 2015) and 1,000 individuals present on Tinian (DON in litt. 2014). On Guam and Rota, there are fewer than 630,000 (T. Marler, UOG, pers. comm. 2013). This number does not distinguish between successfully reproducing adults and juveniles (T. Marler, UOG, pers. comm. 2013), which, because of the effects of the cycad aulacaspis scale (*Aulacaspis yasumatsui*), implies that the number of extant individuals that can successfully reproduce is much lower. On Guam, there are four fragmented occurrences, totaling fewer than 516,000 individuals: one occurrence along the shoreline to the base of the limestone cliffs on the north side; a second occurrence beginning at the forest edge along the cliffs and continuing into the forest on the north side; a third occurrence on the northern plateau; and a fourth occurrence along the ravines and rock outcrops on the southern side, with a few individuals occurring across the savanna.

On Rota, there are four known occurrences within the forest ecosystem, totaling fewer than 111,500 individuals (Marler 2013, in litt.). On the northeast shore the first occurrence totals fewer than 25,500 individuals; the second occurrence, on the northwest shore, totals fewer than 21,600 individuals; the third occurrence on the south shore totals fewer than 63,600 individuals; and the fourth occurrence on Wedding Cake peninsula totals fewer than 300 individuals.

Life History and Ecology

Cycas micronesica is the only native gymnosperm in the Mariana Islands. Cycads are dioecious, and both sexes bear reproductive structures that are relatively massive amongst gymnosperms (*e.g.* conifers). Approximately 300 cycad species and subspecies exist across much of the tropics and subtropics, but cycads remain the most threatened group of plant species on earth

(Donaldson 2003, p. 1). *C. micronesica* (sometimes considered *Cycas circinalis* in early references) occurs in limestone forests in Guam and Rota, with a smaller number of occurrences in volcanic soils typical of southern Guam (Stone 1970, p. 65). Few studies exist that describe cycad natural history and ecology in the Mariana Islands, and much of the current literature is focused on its decline and effects from introduced pests. However, *C. micronesica* is a food source for fanihi (*Pteropus mariannus mariannus*), which feed on its fruits (Wiles and Fujita 1992, p. 27), as well as for the Chamorro people, who process the fruits to rid the naturally-occurring toxins (Safford 1905, p. 71). Most cycads have historically been assumed to be wind pollinated, but recent research on a number of species has revealed that insects play in important role in pollination (Hall et al. 2004, p. 334; Kono and Tobe 2007, p. 853), even emitting chemical cues to attract pollinator insects (Schneider et al. 2002, p. 285). *C. micronesica* cones emit strong smells when pollen is mature (Raulerson and Rinehart 1991, p. 4), and evidence indicates pollination by both insects and wind (Terry et al. 2009, p. 96).

Population Dynamics and Current Status

Just 10 years ago, *Cycas micronesica* was ubiquitous on the island of Guam, and similarly common on Rota. It was the most abundant tree in Guam forest inventory surveys in 2002 (Donnegan et al. 2004, p. 16). *C. micronesica* is currently under attack by a nonnative insect, the cycad aulacaspis scale (*Aulacaspis yasumatsui*) is causing rapid mortality of all life stages of the plant (Marler 2014, in litt.). As of January 2013, *C. micronesica* mortality reached 92 percent on Guam, and cycads on Rota are experiencing a similar fate from the cycad aulacaspis scale (Marler 2013, in litt.; USFWS 2015, p. 59435). All seedlings of *C. micronesica* in a study area were observed to die within 9 months of infestation by *A. yasumatsui* (Marler and Muniappan 2006, p. 3; Marler and Lawrence 2012, p. 233; Western Pacific Tropical Research Center (WPTRC) 2012, p. 4; Marler 2013, pers. comm.).

As mentioned above, there are fewer than 630,000 on Guam and Rota. However, this number does not distinguish between successfully reproducing adults and juveniles (T. Marler, UOG, pers. comm. 2013). Because the scale causes mortality of all life stages of *Cycas micronesica*, it prevents reproduction and recruitment into the population on Guam and Rota (USFWS 2015, p. 59435). The cycad aulacaspis scale is not present on Tinian and Pagan. Overall, the population of *C. micronesica* is in declining because of the scale and other threats (see below).

Threats (USFWS 2015, p. 59435; see also General Environmental section of this Opinion)

- *Cycas micronesica* is affected by multiple pest species, with *Aulacapsis yasumatsui*, an introduced cycad specialist armored scale insect, being the most significant threat (Marler and Muniappan 2006, p. 3). A specialist scale predator beetle, *Rhyzobius lophanthae*, was introduced purposefully to treat the *A. yasumatsui* outbreak with some positive results (Marler and Lawrence 2012, pp. 234-238). However, a number of other insects, including cycad blue butterfly (*Chilades pandava*) and a native longhorn beetle that bores cycad stems (*Dihammus marianarum*), also contribute to declining health and mortality in Guam cycad populations (Marler and Muniappan 2006, p. 3; Marler and Lawrence 2012, pp. 238-240).
- Loss and degradation of habitat from development, military training, urbanization, nonnative plants and agriculture.
- Feral pigs and introduced deer are also threats through herbivory and physical damage.

- Stochastic events such as typhoons will continue to degrade forest and the affected forest areas may require several years to regenerate.
- Drought and climate change will exacerbate many of these threats.

Survival and Recovery Needs

In order to recover *Cycas micronesica*, individuals of this species need to be protected on Guam, Rota, Tinian, and Pagan. *C. micronesica* populations should have age structures consisting of seedlings, juveniles, and adult plants. Expanded trials with biocontrol, especially targeting *Aulacapsis yasumatsui*, should be considered to help stabilize the population (Marler and Lawrence 2012; p. 240). In addition, future invasions from other pests must be prevented (Marler and Lawrence 2012; p. 240). Feral pigs and introduced deer are also threats through herbivory and physical damage, further compounding effects from insects (Marler and Lawrence 2012; p. 238); therefore, ungulate control and fencing restoration sites are also crucial steps in managing cycad populations.

Management actions that have occurred in the last five years:

- Since 2007, DON has been maintaining an outplanted population of *C. micronesica* in fenced areas on the island of Tinian, which were selected to represent a broad genetic diversity. These outplantings number about 1,000 mature individuals in each of five fenced exclosures, are maintained to ensure health and survival, and funding for this maintenance is ensured through 2020.

- Five one-acre fenced cycad plots that have been established on AAFB are being maintained as part of a conservation measure from the 2006 ISR Strike Biological Opinion (USFWS 2006 p. 13, AAFB 2015 p. 8). In addition, monitoring is being conducted within these plots to help inform future management actions (JRM 2015x, p. 2-1).

Status of *Heritiera longipetiolata*

Legal Status

Heritiera longipetiolata (ufa halomtano in Chamorro) was listed as threatened under the ESA in 2015 (USFWS 2015, 73 pp.). No critical habitat has been designated for this species. The Service has not completed a recovery plan for the *H. longipetiolata.*

Species Description and Current Known Range

Heritiera longipetiolata is a medium-sized tree in the hibiscus family (Malvaceae). The tree is stout and the trunk is often twisted. The alternate ovate-oblong leaves are large (15-30 cm long and 8-15 cm wide) and borne on long petioles that are abruptly enlarged at the base of the leaf blade. The upper leaf surface is dark green and slightly glossy. Flowers are yellowish-tan in color. The fruits are brown, woody and about the size of a Brazil nut, with thick walls (Raulerson and Rinehard 1991, p. 94).

Historically, *Heritiera longipetiolata* is reported from Guam, Rota, Saipan, and Tinian, within the forest ecosystem (Stone 1970, p. 420; Raulerson and Rinehart 1991, p. 94; CPH 2012c−*Online Herbarium Database*; GBIF 2014−*Online Herbarium Database*). By 1997, there were about 1,000 individuals on Guam, several hundred on Tinian, and fewer than 100 on Saipan, with no known remaining individuals on Rota (Wiles in IUCN Red List 2014, in litt.). On Guam, *H. longipetiolata* occurs mostly on the northern end of the island where it grows on limestone cliffs. Currently, *H. longipetiolata* is known from 10 occurrences totaling approximately 200 individuals, on Guam, Saipan, Tinian, and Rota, all within the forest ecosystem (M and E Pacific, Inc., pp. 6, 8, 31, 78; Harrington et al. 2012, in litt; Grimm 2013, in litt).

Life History

Little is known about the life history of *Heritiera longipetiolata*. This species can be propagate by seeds, but is never found in riverine or coast strands. Instead, it occurs in forests with crevices of rough limestone, especially on cliffs (Raulerson and Rinehard 1991, p. 94). It is rarely observed flowering and fruiting (DAWR 2006, p. 120).

Current Status

On Guam, the total population of *Heritiera longipetiolata* is approximately 90 individuals; on Tinian, there are between 30 and 40 individuals of *H. longipetiolata*, and possibly more in forest areas (Spaulding 2013, in litt.; USFWS 2015; Williams 2013, in litt.; Spaulding 2015, in litt.); on Saipan, *H. longipetiolata* is known from 3 occurrences, totaling at least 53 individuals, with several hundred seedlings beneath the trees (Camacho and MES 2002, pp. 38−39); and on Rota, more recent information indicates that there is at least one individual of *H. longipetiolata* (Cook 2010, in litt. cited in CNMI-DLNR 2015, in litt.). We estimate there are roughly 200 individuals remaining across its range (Guam, Saipan, Tinian, and Rota) (USFWS 2015, p. 59436).

Threats (USFWS, p. 59436; see also General Environmental section of this Opinion)

- Loss and degradation of habitat – Development, military training, urbanization, agriculture, nonnative plants and animals (*e.g.*, insects).
- Herbivory by ungulates and crabs.
- Stochastic events - Typhoons will continue to degrade forest and the affected forest areas may require several years to regenerate.
- Climate change will further exacerbate many of the above threats in the future.

Survival and Recovery Needs

In order to recover *Heritiera longipetiolata*, the remaining populations or occurrences of this species need to be protected throughout its range. *H. longipetiolata* populations should have age structures consisting of seedlings, juveniles, and adult plants. Ungulate control should be implemented throughout its range, especially on Guam. In addition, control of nonnative plants and invasive insects and outplanting of *H. longipetiolata* in protected areas are critical for its

recovery. Restoration works should focus on outplanting saplings within protected and ungulate-free areas.

Management actions that have occurred in the last five years:

- From 2014-2015, the Service funded GPEPP to work on the propagation of *Heritiera longipetiolata*. GPEPP's mission is to prevent the extinction of Guam's rarest plant species that have fewer than 200 individuals in the wild on Guam. GPEPP works with conservation partners to protect wild populations and reintroduce plants to their natural habitat. The Service is working with GPEPP in efforts to outplant *H. longipetiolata* within protected areas on Guam.

- GPEPP is building a relational database and geodatabase to connect all plant handling activities. Records from the different GPEPP projects and activities will be stored in this database. The database will house ex situ (wild populations and outplanted population records) and in situ (seed storage, in vitro propagation and Rare Plant Nursery) data. This work is conducted under a U.S. Forest Service grant.

Recommendations for Future Actions (adapted from DAWR 2006, p. 120):

- Collect seeds from fruiting trees and develop a nursery of seedlings for outplanting in protected areas throughout its range.
- Outplant or relocate wild seedlings/saplings to increase their distribution.
- Eradicate or control ungulates.
- Install enclosures around trees to protect seeds and seedlings from ungulate.
- Prevent and treat insect infestation on trees.
- Determine life history traits.

Status of *the Mariana eight-spot butterfly*

[INSERT HERE]

Status of *Tabernaemontana rotensis*

Legal Status

Tabernaemontana rotensis was listed as threatened under the ESA in 2015 (USFWS 2015, 73 pp.). No critical habitat has been designated for this species. The Service has not completed a recovery plan for *T. rotensis*.

Species Description and Current Known Range

Tabernaemontana rotensis occurs on Guam and Rota, in the forest ecosystem (UOG 2007, p. 6). *T. rotensis* is a small to medium-sized (8-10 m tall) tree in the dogbane family (Apocynaceae). Its leaves are thin, light green, opposite, and 15-30 cm long. Flowers are white, elongate, slender, and branch from the tree. *T. rotensis* produce conspicuous orange fruit that are twinned or single and beaked (UOG 2007, p. 6; GPEPP 2015, p. 22).

Life History

Tabernaemontana rotensis occurs in forests with crevices of rough limestone (Raulerson and Rinehard 1991, p. 94) and are able to colonize sites that occur in full sun or in deep shade (UOG 2007, p. 16). On Guam, the population structure includes emerging seedlings, young juveniles, and reproductive mature individuals with an immense range in canopy size. Because of the loss of frugivore bird species on Guam, seed dispersal is very limited and spatial distribution of individuals are clumped within specific areas (UOG 2007; pp. 4, 28). Seedling establishment frequently occurs within the vicinity of mature individuals. These seedlings develop in extreme competition with each other, and many of them become stunted and some die (UOG 2007; pp. 14, 22).

In the absence of typhoons, one study showed that the *Tabernaemontana rotensis* population exhibited an increase in the number of trees flowering in August to October. The months following these months revealed the greatest percentage of trees with immature or orange fruit (UOG 2007, p.23). It also was determined that 40 to 80 percent of trees had a least some flowering occur every month. In typhoon conditions, *T. rotensis* develops a synchronized pulse of flowering about one month after the typhoon. This pulse of flowering leads to a mast seeding event about four months after the typhoon (UOG 2007, p. 29).

The fruit of *T. rotensis* reaches full size approximately 30 to 35 days after flowering. Fruit color changes from bright green to dull green in subsequent months, and a dull orange color break occurs in 50 to 60 days after flowering (UOG 2007, p. 24).

Current Status

In 2007, more than 21,000 *Tabernaemontana rotensis* individuals, comprising of seedlings, juveniles and mature trees, were observed throughout AAFB on Guam. Individuals were located in forest areas: Ritidian Point, Pati Point, HMU, and central and southeast edge of AAFB (JRM 2016, p. 5; UOG 2007, pp. 32-42). *T. rotensis* are present in an area north of route 3A (or northwest of the HMU) on AAFB (AAFB 2014, p. 23). At least five individuals of *T. rotensis*

also occur within the GNWR. In addition, 12 saplings of *T. rotensis* have been outplanted on the GNWR (L. Gutierrez, Service, pers. comm. 2016). Multiple *T. rotensis* saplings naturally occur in the forest on the east or north side of the road, close to the cliffline, which is located outside the GNWR boundary near the old gate (A. Gawel, Service, pers. comm. 2016).

In 2014, the CNMI DLNR observed nine individuals on Rota. These individuals were spread across the western, southern, and eastern parts of the island (CNMI DLNR 2014, in litt.). Additionally, there are 30 surviving outplanted individuals, ranging in size from 4 to 23 ft (1.3 to 7 m), spread out across the island (J. Manglona, T. Reyes, R. Ulloa, pers. comm. 2014 cited in CNMI DLNR 2014, in litt.).

Threats (UOG 2007, p. 28-30; USFWS 2015, p. 59436; see also General Environmental section of this Opinion)

- Loss and degradation of habitat from agriculture, urban development, military training, nonnative animals and plants, and fires
- Forest fragmentation
- Limited dispersal and recruitment in new habitat.
- Stochastic events - Typhoons will continue to degrade forest and the affected forest areas may require several years to regenerate.
- Climate change will further exacerbate many of the above threats in the future.

Survival and Recovery Needs

In order to recover *Tabernaemontana rotensis*, the remaining individuals of this species need to be protected on Guam and Rota. *T. rotensis* populations should have age structures consisting of seedlings, juveniles, and adult plants. Ungulate and invasive species control should be implemented throughout its range. On Guam, restoring areas with this species' natural dispersers (*e.g.*, native frugivore birds) would expand the distribution of *T. rotensis* population into new habitat niches, niches that would have likely been naturally occupied by the *T. rotensis* population prior to the loss of seed dispersal on Guam. Outplant or relocate wild seedlings within protect areas to increase their abundance and distribution on Guam and Rota.

Management actions that have occurred in the last five years:

- From 2014-2015, the Service funded GPEPP to work on the propagation of *Tabernaemontana rotensis*. GPEPP's mission is to prevent the extinction of Guam's rarest plant species that have fewer than 200 individuals in the wild on Guam. GPEPP works with conservation partners to protect wild populations and reintroduce plants to their natural habitat. The Service is working with GPEPP in efforts to outplant *T. rotensis* within protected areas on Guam.

- GPEPP is building a relational database and geodatabase to connect all plant handling activities. Records from the different GPEPP projects and activities will be stored in this database. The database will house ex situ (wild populations and outplanted population records) and in situ (seed storage, in vitro propagation and Rare Plant Nursery) data. This work is conducted under a U.S. Forest Service grant.

Recommendations for Future Actions:

- Continue monitoring and survey efforts for *Tabernaemontana rotensis*.
- Collect seeds from fruiting trees and develop a nursery of seedlings for outplanting in protected areas throughout its range.
  - *T. rotensis* responds to typhoons with a synchronized flowering pulse (UOG 2007, p. 6). Conservation efforts should ensure harvest of the mast seeding that occurs about four months after the passage of a typhoon (UOG 2007, pp. 22, 29).
- Outplant or relocate wild seedlings to increase their distribution.
  - *T. rotensis* seedlings typically occur in a cluster near the parent tree. The seedlings compete with one another for light and other resources, and not all seedlings survive. Resource managers would benefit from transplanting some of these seedlings prior to their death (UOG 2007, p. 22). This approach also would thin out crowded seedlings and possibly ensure more of them remain alive (UOG 2007, p. 23).
- Eradicate or control ungulates and invasive plants.
- Prevent establishment of introduced invasive species (*e.g.*, insect pests).

Status of the *Tuberolabium guamense*

Legal Status

Tuberolabium guamense (no common name) was listed under the ESA as threatened in 2015 (USFWS 2015, 73 pp.). No critical habitat has been designated for this species. The Service has not completed a recovery plan for *T. guamense*.

Species Description and Current Known Range

Tuberolabium guamense is an epiphytic orchid with roots that elevate the leaves and flowers away from the tree trunk. Leaves are leathery, oblong, about 13 cm long and 1.5 cm wide. Small white flowers are on a rachis about 3.5 cm long (USFWS 2014f). *Tuberolabium guamense* occurs in forest ecosystems. *T. guamense* is predominantly known from the islands of Guam and Rota, with a few scattered historical occurrences on Tinian and Aguiguan (Raulerson and Rinehart 1992, p. 127; CPH 2012f-*Online Herbarium Database;* GBIF 2012f-*Online Database*).

Life History

Similar to other epiphytic orchids, *Tuberolabium guamense* can take advantage of the microclimate, which are found on the trunk, lower branches, under the canopy, and prefers shade or moderate light. *T. guamense* clings strongly onto their hosts with a strong developed root system and uses the moisture and organic debris caught in the crevices and bark of the host for nourishment. The humid tropical air is absorbed for additional moisture and nutrients (Landscape and garden 2015, in litt).

There is limited information on the life history and habitat preferences of *Tuberolabium guamense*. However, observations of *T. guamense* indicate this species is associated with *Ptenophyllum* (worm orchid) and moss on host trees. *T. guamense* is generally located in more humid areas that are protected from wind within the forest (USFWS 2016, in prep). Occurrences of *Tuberolabium guamense* are uncommon; however where they occur, they are present in clusters. For example, at least 145 individuals were located on four trees in in forest within the Finegayan area on Guam. Within the same forest area, over seventy percent (approximately 5,300 individuals) of the known population of *T. guamense* occurs in the wild (DON 2016x, p. 1). In addition, biologists observed *T. guamense* present in areas with low to moderate sunlight within the forest, and no individuals were found in more shared areas (USFWS 2016, in prep).

Within the northern Guam, *T. guamense* was observed growing on bark of *Vitex parvifloara* at a height of 3 to 20 ft and some individuals were observed on *Guamia mariannae* (JRM 2016, p. 6). *T. guamense* occurs along rivers on Guam, mostly on *Areca catechu* and *Cocos nucifera*. They were occasional found on *Vitex* and *Pandanus* (JRM 2016, p. 8). On Rota, this species occurs within the native tree canopy, with the majority of individuals observed growing on *Hernandia labyrinthica*, *Premna obtusifolia*, and *Eleocarpus joga* (USFWS 2015, 73 pp.).

Current Status

Approximately 7,300 individuals of *Tuberolabium guamense* occur on Guam (DON 2016x, p. 1) and 239 individuals of *T. guamense* are present on Rota (Zarones et al. 2015c, in litt.). On Guam, the 7,300 individuals are present on DoD land, with the majority of individuals occurring within northern Guam (DON 2016x, pp. 1-2). On Rota, *T. guamense* along 6 of 18 transects surveyed on the Sabana, with a healthy population structure consisting of seedlings, juveniles, and flowering adults (Zarones et al. 2015c, in litt.). This species was once relatively abundant on Guam and Rota, but has since declined in numbers because of threats (USFWS 2015, p. 59439).

Threats (adapted from USFWS 2015a, pp. 59431, 59452, 59454-5, 59457, 59459, and 59467:

- Loss or Degradation of Habitat
  - Incremental habitat loss due to wild fire, urbanization, and agricultural development is increasingly threatening the availability of habitat.
  - The ongoing and proposed expansion plans of DoD training and operations on Guam are threatening the remaining *T. guamense* habitat and potential future conservation efforts from the activities associated with the expansion.
  - As numbers of cattle and ranchers increase on Tinian, there may be a greater risk of cattle potentially escaping and becoming feral. Both feral and domestic cattle can drastically alter the landscape (Wiles et al. 1990, pp. 176–177), and depending on the location and amount of land designated as pasture land for domestic cattle, negative impacts to the forest ecosystem may be observed in the future, minimizing the available habitat.
  - The presence of nonnative plants and other nonnative ungulates (pigs, goats, and water buffalo), and Philippine deer, further degrades forest habitats, thus impeding their ability to survive.

- Predation

  - Nonnative slugs have been observed to cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds), including orchids, and are considered a threat.

- Stochastic Events
  - Typhoons will continue to degrade forest and the affected forest areas may require several years to propagate.

- Climate Change
  - We anticipate the effects of climate change will further exacerbate many of the above threats in the future (USFWS 2015b, pp. 59435-6).

Survival and Recovery Needs

In order to recover and ensure the survival of *Tuberolabium guamense*, wild populations of this species and their habitat need to be protected on Guam and Rota. Augmentation of wild populations is needed, as well as the reintroduction of *T. guamense* within their historic ranges, i.e. Tinian and Aguiguam. *T. guamense* populations should have age structures consisting of seedlings, juveniles, and adult plants. The occurrence of large, feral ungulate populations on islands further degrades the remaining forest habitats, thus lowering their value for *T. guamense* recovery. Ungulate control needs to be implemented throughout the range of this species. Similarly, control of nonnative plants and slugs is critical for their recovery.

Management actions that have occurred in the last five years:

- For fiscal years 2014-2015, the Service funded the Guam Plant Extinction Prevention Program (GPEPP) to work on the seed germination and propagation of *T. guamense*. GPEPP is working on cultivation of *T. guamense* in their plant nursery.

- GPEPP is building a relational database and geodatabase to connect all plant handling activities. Records from the different GPEPP projects and activities will be stored in this database. The database will house ex situ (wild populations and outplanted population records) and in situ (seed storage, in vitro propagation and Rare Plant Nursery) data. This work is conducted under a U.S. Forest Service grant.

Recommendations for Future Actions:

- Monitor the status of *T. guamense*.
- Determine life history and habitat preferences.
- Identify areas that are needed to be protected for the conservation of *T. guamense*.
- Eradicate or control ungulates within *T. guamense* habitat.
- Determine the best methods in augmenting populations and relocating and/or reintroducing *T. guamense* into protected areas within its historic range.
- Prevent and treat insect infestation on trees.

F. ENVIRONMENTAL BASELINE OF THE SPECIES

General Environmental Baseline
Below we provide a general overview of the status of, and threats to, limestone forest habitat within the action area, followed by species-specific environmental baseline sections. This overview section focuses on habitat of the three extirpated birds, Mariana fruit bats, and Mariana eight-spot butterflies on Guam. In addition, *B. guamense*, *C. micronesica*, *D. guamense*, *H. longipetiolata*, *S. nelsonii*, *T. rotensis*, and *T. guamense* occur within the forest ecosystem. In order to recovery populations of these listed species, sufficient habitat needed for all life stages need to be available. Therefore, protecting the remaining habitat on Guam is critical for the future recovery and survival for all the listed species addressed in this Biological Opinion.

Overview of Guam

Guam is the largest and southernmost island of the Marianas. It is almost 50 kilometers (km) long and from 7 to 15 (km) in length. The northern part of Guam is a limestone plateau interrupted by a few low hills, of which two, are volcanic in nature, and others exclusively coralline limestone. The original forest on limestone was of large trees, with a thick canopy overhead (see below for further description). The northern part of the island gently slopes to the southward from about 200 meters to about 100 meters at the narrow waist of the island. There is no surface water in the northern part of the island (Fosberg 1960, pp. 51-52). Only in the southern and central parts of Guam are there permanent streams (Stone 1970 p. 12). The central part of Guam includes a mixture of volcanic and limestone types. The southern part of Guam is hilly, largely of volcanic (*e.g.*, basalts) but in several places are capped with a layer of limestone (Stone 1970 p. 12). The southern half of the island is made up of deeply weathered volcanic material with patches of limestone and numerous streams (Fosberg 1960, p. 52). Forest habitat is broken up by ridges and flats covered by grass. The forests in these areas tend to resemble that on limestone; however the forest is thicker and lower stature tree (Fosberg 1960, p. 53; Stone 1970, p. 18). Within lower elevations, ravine forests occur primarily within the ridges in ravines, valley bottoms, and steep slopes.

Limestone karst forests on Guam

Limestone karsts are sedimentary rock outcroppings consisting primarily of calcium carbonate and are recognized as important ecosystems, with high species diversity (Mueller-Dombois and Fosberg 1998, p. 217; Clements et al. 2006, pp. 733-734). The high species diversity on karsts arises from the numerous ecological niches created by complex terrains and variable climatic conditions (Clements et al. 2006, p. 734). On Guam, karst is found on an uplifted karst plateau in the northern half of the island and on uplifted weathered volcanic terrain in the southern half (Fosberg 1960, p. 54; Stone 1970, p. 12; Mueller-Dombois and Fosberg 1998, p. 241). The limestone soils of north and south Guam were historically forested (Stone 1970, p. 14; Mueller-Dombois and Fosberg 1998, p. 270; Guam Department of Agriculture 2010, p. 7), and limestone forest on Guam is composed primarily of mature growth of native trees and plants with a moderately dense canopy 10-30 m high (DAWR 2006, p. 19). We define primary limestone forest as forest with vegetation that was never cleared and is dominated by native species (Fosberg 1960, p. 56; DAWR 2006, p. 218).

Primary limestone forests are critical for Guam's native flora and fauna (Stone 1970, p. 22; USFWS 2005a, p. iv; DAWR 2006, p. 28; DON 2014b, p. 3-40). They retain key functional components of native forests such as large native trees and high canopy cover (Fosberg 1960, p. 56; Mueller-Dombois and Fosberg 1998, p. 217 and 270; DON 2014b, p. 3-40), and are necessary for the recovery of listed species on Guam (Jenkins 1983, p. 22; Michael 1987; Morton et al. 1999, p. 22). Intact primary limestone forests harbor greater tree species diversity than degraded habitat (Stone 1970, p. 22) and provides habitat for a broad diversity of wildlife; these forests are also highly productive and often store more carbon than degraded forests (Caves et al. 2013, p. 7). The primary limestone forest on AAFB is considered some of the best native limestone forest left on Guam to serve as habitat for listed species (Morton 1996, p. 69).

Threats to Guam's limestone forests

Over the past several centuries, Guam has lost much of the native forest to agriculture, a growing human population, economic development, and military activities (Mueller-Dombois and Fosberg 1998, p. 270; USFWS 2009d, p. 27). The distribution of primary limestone forest on Guam has been steadily declining (Fosberg 1960, p. 54; DAWR 2006, p. 28). Although little is known about the nature of Guam's vegetation before World War II, progressive alteration of the island's vegetation clearly began with human colonization (Fosberg 1960, p. 54). On limestone soils, native forest was cleared and replaced by coconut plantations, open fields and gardens, pasture, and secondary forest (Mueller-Dombois and Fosberg 1998, p. 242). During World War II, large areas were cleared and some habitat was destroyed during heavy fighting (Fosberg 1960, p. 54).

Currently, the remaining limestone forests on Guam face numerous threats including habitat fragmentation and loss, lack of management, introduced ungulates, invasive species, typhoons, forest conversion, and loss of pollinators (USFWS 2005a, p. 27; DAWR 2006, p. 28; USFWS 2008a, p. 17-18). These combined threats will degrade the habitat quality of remaining limestone forests and limit the acres of high quality primary limestone forest habitat available to recover listed species on Guam. Currently, forested areas cover approximately 48 percent of Guam (DAWR 2006, p. 31), with only 13 percent of Guam covered with limestone forests (Brown 2005 as cited in DAWR 2006, p. 28).

Forest Habitat Fragmentation, Degradation, and Loss
Habitat fragmentation is a change in habitat configuration caused by clearing, development, invasive species, typhoons, and ungulates that causes remaining habitat to occur in patches among areas of non-habitat (Noss et al. 2006, p. 213). Habitat fragmentation creates edges that have different properties than the habitat itself. For example, edges often have different microclimate patterns that are drier, less shaded, and warmer than forest interiors; they are often areas with increased predation and serve as entry points into native habitats for invasive vegetation, pests, and pathogens (Noss et al. 2006, p. 228). Edges can affect avian density up to 60 m into the forest, and affect the forest canopy up to 150 m (Murcia 1995, p. 59). Habitat fragmentation and edges can result in localized extinctions, shifts in community composition, increases in invasive species, increased predation, and in suitable habitat becoming unsuitable due to pollution, invasive species, physical size, or barriers blocking access to habitats (Groom and Vynne 2006, p. 174; Noss et al. 2006, 38 pp). Habitat fragmentation has been implicated in reduced species richness, avian abundance, productivity, and food supply (Blake and Karr 1987,

VanderWerf 1993, Burke and Nol 1998, Trine 1998, Porneluzi and Faaborg 1999). Overall, edges have deleterious effects to wildlife populations and ecological processes (Murcia 1995, p. 58; Laurance 2000, p. 134) and may affect forests at larger landscape scales (Laurance 2000, p. 134).

Habitat degradation and loss on Guam has been caused by various human activities including agriculture, mining, forestry, fires, infrastructure development, military training, urbanization, industry, pollution (including light, noise, and toxic chemicals), and changes in community and ecosystem structure due to invasive species (Groom and Vynne 2006, p. 164; USFWS 2008a, p. 17). Habitat loss and degradation from human activities is a threat to recovery of listed species on Guam (USFWS 2008a, p. 17; USFWS 2012c, p. 3).

Introduced Ungulates
Non-native ungulate species that occur in Guam include pigs (*Sus scrofa*), Philippine deer (*Cervus mariannus*), and Asiatic water buffalo (*Bubalis bubalis*). Ungulates have caused severe damage to Guam's forests by browsing on plants, causing erosion, inhibiting plant growth and regeneration, and facilitating the establishment of invasive plants, which can impede forest regeneration by displacing or smothering native species (USFWS 2009d, p. 27). For example, deer and pigs foraging on fallen fruits and seedlings of the native breadfruit (*Artocarpus mariannensis*), an important fruit bat food, in combination with impacts from typhoons, have resulted in a decline in the number of native breadfruit trees on Guam (Wiles 2005; p. 509).

Introduced pigs are extremely destructive and have both direct and indirect effects on native plant communities. While rooting in the soil in search of invertebrates and plant material, pigs directly affect native plants by disturbing and destroying vegetative cover and trampling plants and seedlings. They may also reduce or eliminate plant regeneration by damaging or eating seeds and seedlings. Pigs are a major vector for the establishment and spread of competing invasive non-native plant species, by dispersing plant seeds on their hooves and coats as well as through the spread of their feces (Diong 1982, pp. 169-170), and by fertilizing the disturbed soil with their feces (Matson 1990, p. 245; Siemann et al. 2009, p. 547). Pigs feed preferentially on the fruits of many non-native plants, spreading the seeds of these invasive species through their feces as they travel in search of food. In addition, rooting pigs contribute to erosion by clearing vegetation and creating large areas of disturbed soil, especially on slopes (Smith 1985, pp. 190, 192, 196, 200, 204, 230–231; Stone 1985, pp. 254–255, 262–264; Medeiros et al. 1986, pp. 27–28; Scott et al. 1986, pp. 360–361; Tomich 1986, pp. 120–126; Cuddihy and Stone 1990, pp. 64–65; Aplet et al. 1991, p. 56; Gagne and Cuddihy 1999, p. 52).

On Guam, feral pigs were introduced in the 1600s, established a feral population by 1772, and distributed island wide by the early 1900s (Conry 1988, p. 26). As documented in other locations, wallowing, rooting, and trampling are common in most forested areas and can be locally severe (Conry 1988, p. 27). A large complex of wallows and feeding sites in Tarague Basin on AAFB measured over 5.7 ac (2.3 ha), and was stripped of all ground cover with no tree regeneration (Conry 1988, p. 27). On AAFB, densities of Philippine deer and feral pigs were estimated at 1.8 deer per hectare (0.8 deer per acre) and 0.4 pigs per hectare (0.2 pigs per acre), which are some of the highest densities recorded in the world (Knutson and Vogt 2003, unpubl. manuscript).

Philippine deer were introduced to Guam in the 1770s (Safford 1905, p. 76), and are distributed throughout the island (Conry 1988, p. 27). Heavy browsing pressure has been documented, even at relatively low densities, and browse lines are common (Conry 1988, p. 27). Deer populations in the 1990s appeared to be expanding (Wiles et al. 1999, p. 193), and may be the largest in Micronesia (p. 200). Philippine deer have caused significant changes in forest structure and species composition in native ecosystems on Guam, and are not considered compatible with conservation of native ecosystems and recovery of endangered species (Wiles et al. 1999, p. 193).

The Asiatic water buffalo was introduced to Guam in the 1600s from the Philippines (Conry 1988, p. 27). High densities, and the gregarious habits of Asiatic water buffalo, have resulted in habitat damage such as mud wallows, broad trails, vegetation trampling, and tracks, and some areas were so heavily trampled that ground cover has been denuded and soil erosion scars and slumping are evident (Conry 1988, pp. 27-28). Asiatic water buffalo occur primarily on the Ordnance Annex and surrounding non-Navy lands in southern Guam, with a population estimated at 50-60 animals (USFWS 2008a, p. 18).

Conversion of Forest to Savanna in Southern Guam
Savanna areas in southern Guam are enlarging into previously forested areas as a result of human-caused wildfires and grazing (Stone 1970, p. 14; Mueller-Dombois and Fosberg 1998, p. 242). To estimate the rate of historical forest conversion to savanna, Greenlee (2010) delineated areas that were dominated by forest vegetation in 1975 aerial photographs and compared them to recent infrared imagery. Based on this analysis, approximately 1,119 ac (453 ha) of forest was converted to savanna in southern Guam since 1975; this estimate indicates the average rate of forest loss in southern Guam is approximately 37 ac/year (15 ha/year) (Greenlee 2010).

Habitat Destruction and Modification by Typhoons
Guam has been affected by typhoons in 37 of the last 50 years (USFWS 2005a, p. 32). Super-typhoons (with wind gusts of over 240 km (150 mi) per hour) occur approximately once every five years (the last one, Pongsona, occurred in 2002). Typhoons destroy native vegetation by opening the canopy and modifying the availability of light, and create disturbed areas conducive to invasion by non-native pest species (Asner and Goldstein 1997, p. 148; Harrington et al. 1997, pp. 539-540). Typhoons also can cause defoliation (loss of leaves), uprooting of trees, and breakage of stems, branches, and trunks of trees depending on the severity and duration of the storm and its point of impact (Brokaw and Walker 1991, p.442). Super-typhoons fragment and decrease the suitability of existing habitat, and exacerbate the effects of introduced plants and ungulates (USFWS 2005a, p. 34). Following a typhoon, forest canopies may be disrupted, facilitating the establishment and spread of introduced plants. Climate models indicate that hurricanes in the northwestern Pacific are expected to increase in intensity, frequency, and duration by 2200 and continue to increase further into the future (Emanuel et al. 2008, p. 360). Therefore, we expect habitat destruction and modification by typhoons to increase in the future.

Loss of Pollinators, Seed Dispersers, and Frugivores
The loss of forest birds on Guam by brown treesnakes has caused a disruption in the ecosystem services provided by birds as pollinators, seed dispersers, and frugivores (Mortenson et al. 2008, p. 2146; Caves et al. 2013, p. 7). Seeds are dispersed significantly farther from parent trees on islands with birds compared to Guam, and seed ingestion by birds doubles to quadruples the

chance of germination for plant species (Rogers 2011, p. 2). The combination of loss of seed dispersal and reduced germination can produce major changes in the spatial pattern, abundance, and diversity of Guam's forests as a result of bird loss (Rogers 2011, p. 2). In addition, seed set and seedling recruitment were significantly higher on Saipan than Guam for bird pollinated trees (Mortensen et al. 2008, p. 2146). These studies concluded that the loss of ecosystem services provided by birds will cause a loss in species diversity, distribution, and abundance; slow regeneration of degraded forests; and reduce plant species recruitment (Mortensen et al. 2008, p. 2146 and 2153; Rogers 2011, p. 2; Caves et al. 2013, p. 5).

Human Disturbance

The listed birds and bat on Guam are also threatened by disturbance from human activities including, but not limited to, noise from military training (aircraft, munitions, firing ranges, vehicles, etc.), noise from recreational pursuits (hiking, and hunting), human voices, and construction noises. These disturbances not only negatively affect species, but reach into forested interiors and degrade the quality of habitat for listed species. The listed birds and bat addressed in this consultation are all sensitive to human disturbance, and as development continues on Guam, disturbance-free forested habitats are increasingly rare on Guam.

Land Management on DoD Lands

The majority of remaining limestone forests on Guam occurs on DoD lands at AAFB and the Naval Base Guam's NMS. As noted above, the primary limestone forest on AAFB is considered some of the best native limestone forest left on Guam to serve as habitat for listed species (Morton 1996, p. 69). The Service and the DoD (USAF, U.S. Navy, and JRM) have worked together over the past 20 years to manage DoD lands for threatened and endangered species. In 1993, a Cooperative Agreement (Agreement) was established between the USAF, U.S. Navy, and the Service for purposes of establishing and managing the GNWR Overlay on DoD lands. The GNWR includes approximately 152 ha of fee simple Service-owned land and 9,106 ha of Overlay Refuge on land owned by DoD. The Agreement, which is still in effect, affirms the parties commitment for a "coordinated program centered on the protection of endangered and threatened species and other native flora and fauna, maintenance of native ecosystems, and the conservation of native biological diversity in cooperation with the Guam Department of Agriculture-Division of Aquatic and Wildlife Resources, consistent with the national defense mission of the Navy." Notably, all signatory parties to the Agreement agreed that Navy lands included within the GNWR shall be managed and administered, consistent with the national defense mission of the Navy, for the following goal: to consult under section 7 of the Endangered Species Act (ESA) on proposed Federal actions that are funded, authorized, or carried out by the Federal government within the Refuge, inclusive of Overlay Refuge lands, "that may impact habitat of endangered or threatened species even if those species are extirpated from the affected area, but are not extinct."

Management of listed species habitat on DoD lands has occurred with some success. The approximately 73-ha (180-ac) Haputo Ecological Reserve Area (ERA) on AAFB and the 12-ha (30-ac) Orote Point ERA on NBG are but two examples. Both were established in 1984, prior to the Agreement, as mitigation for the Kilo Wharf project. The 54-ha (133-ac) Habitat Management Unit (HMU) on AAFB was developed as a conservation measure under the 2006, informal consultation on the Beddown of Training and Support Initiative at the Northwest Field

(USFWS 2006c, p. 2), and currently serves as an experimental site for brown treesnake research and control.

However, in contrast, the DoD has recently proposed to build a LFTRC within an existing 312-acre mitigation site on Overlay Refuge at Ritidian Point on AAFB (DON 2014a, p. 22). This mitigation site is included as a conservation measure under the 2006 ISR Strike Biological Opinion (USFWS 2006b, pp. 12-13). After years of working with partners in selecting and preparing the site, constructing and maintaining the ungulate fence, and spending over $1.1 million (AAFB 2015, p. 15), the proposed construction of LFTRC will result in the loss and degradation of listed species habitat, which was to be protected for listed species, and may result in the removal (as part of this proposed action) of parts or all of the ungulate fence.

Another example showing a lack of success to protect and carry-through conservation and management actions on Overlay Refuge is "Area 50", which was established near NWF on AAFB in 1991 to exclude ungulates and control brown treesnakes in an exclosure. Area 50 was the site for the release of Guam rails in 1998. Biologists were able to refine release techniques at this site and further recovery efforts for the rail. The DOI and USAF were working collaboratively towards building a pre-stressed concrete barrier for brown treesnake control at the site, when the USAF restricted access to the site and ended the recovery project for Guam rails.

In addition, cooperation between the DoD and the Service for land management actions on Overlay Refuge lands has not progressed as originally intended after signing of the Agreement. As DoD and Service staff changed, access became more and more challenging until it reached a point where Service biologists could no longer access Overlay Refuge lands. In recent years, access has improved on Overlay Refuge lands.

Further, in April 2013, beginning with the need for a re-initiation of the 2010 JGPO Biological Opinion, the DON stated that it did not have to consult with the Service under section 7 for actions that may have affected listed species habitat, despite the wording of the Agreement requiring this. This issue was debated on by both agencies (see Consultation History section of this Opinion), until January 2014.

The DoD agencies working on Guam also have a history of non-compliance with provisions of Biological Opinions and section 7 informal consultations. For example, DoD has been out of compliance for nine years with implementation of measures included in the ISR Strike BO (USFWS 2006b). While progress has been made in recent years, including construction of the ungulate exclosure at Ritidian Point (as discussed above), the Service had a long struggle with convincing the USAF to comply with the Biological Opinion. In addition, the DOD has carried out numerous actions that may have resulted in adverse effects to listed species and their habitats without consulting with the Service including installing lighting at Pati Point adjacent to the last fruit bat colony, clearing habitat at Flag Circle, three clearings at Tarague Beach, NWF (for THAAD) and other sites.

The DoD agencies have also not historically managed ungulates to full success on DoD lands to benefit listed species or their habitats. For many years, the DoD relied on a Volunteer Conservation Officer (VCO) program to "manage" ungulates on DoD property. These hunting

efforts were not effective to manage or control the large ungulate populations on DoD lands. The lack of ungulate eradication can have significant adverse effects to native plants, including the listed plants in this Opinion

However, as part of the proposed project, the DON has installed an ungulate fence (DON 2014x, p. 35) and has removed ungulates from NBG. The fence provides an ungulate exclosure for the 3,114 ac (1,260 ha) of the main base of NBG. The fencing project is intended to effectively close off Orote peninsula from any new ungulate incursions and only entry control gates will be left unfenced. These gates are manned twenty-four hours a day/seven days a week.

Finally, the Sikes Act requires the DoD to develop and implement INRMPs for military installations across the United States. INRMPs are prepared in cooperation with the Service and State/Territorial fish and wildlife agencies to ensure proper consideration of fish, wildlife, and habitat needs. The Service, Guam DAWR, and JRM have been working together to finalize a new INRMP.

The JRM continues to fund and implement projects through the draft INRMP. The JRM funded the following monitoring and land survey projects: native snail surveys at the Haputo ERA, rare plant surveys on DoD lands, quarterly Mariana swiftlet surveys, Mariana common moorhen surveys, migratory bird surveys, year-round nesting sea turtle surveys, and field surveys to validate existing vegetation map for NBG. In addition, the JRM is updating and revising the NBG Wildlife Fire Management Plan and Bat Management Plan for AAFB, developing a site specific implementation plan for forest enhancement on Refuge Overlay lands on NBG, and working on a management plan for the HMU on AAFB. The DON has installed floating nesting platforms for the endangered Mariana common moorhen at Fena Reservoir, and plans to develop predator-resistant nesting boxes for Micronesian starlings on AAFB. Other projects include setting up cameras at the Haputo ERA to monitor human activity and the analysis of imagery to determine changes in land cover, land use, and listed species habitat on NBG and AAFB.

In conclusion, the Service and DoD will continue to work on fulfilling requirements under Incidental Take Statements associated with Biological Opinions under the ESA and the Sikes Act. With the recent signing of the MOU (see Section C of this Opinion), the DoD has agreed to protect and manage 5,234 ac for the recovery of the kingfisher. In addition, per negotiations in the 2010 DON BO (USFWS 2010a, p. 51) the DON has committed to support the re-introduction of native endangered or threatened species on DoD lands on Guam consistent with species recovery plans. When the DON and Service mutually agree the constraints to reintroduction of native threatened or endangered species on DoD lands on Guam have been minimized to a point that a feasible and successful re-introduction of the affected species is more probable than not, the DON will work with the Service to develop a re-introduction plan and supporting programmatic biological opinion that ensures such re-introduction efforts are consistent with the species recovery plans and the military mission on Guam.

Brown treesnake predation

The primary threat to native forests birds on Guam for over 60 years has been the non-native brown treesnake. Since the accidental introduction of the brown treesnake to Guam around 1950, Guam's avifauna has been decimated, with most of the native birds disappearing from

Guam's forests (Savidge 1987, p. 660). The brown treesnake was found to be the main cause of the decline of the native forest birds on Guam as it opportunistically preys upon eggs, nestlings, and adult birds (Savidge 1986, 1987, p. 660; Conry 1988). Extirpations of all but two resident forest avian species in southern Guam occurred within 27 to 32 years after the accidental introduction of the brown treesnake. In northern Guam, the average time for the bird populations to decline by 90 percent was 8.9 years (Wiles et al. 2003). Brown treesnakes have been reported to prey on Mariana fruit bats (USFWS 2009d, p. 8). Data collected from 1982 to 2006 at the Pati Point fruit bat colony suggest the brown treesnake preys on non-volant fruit bat pups, thereby inhibiting fruit bat recruitment on Guam (USFWS 2010b, p. vii). Brown treesnake densities are high on Guam and in the 1990s were estimated at 20 individuals per ac (50 per ha) in favorable habitats (Rodda and Savidge 2007, p. 315). The persistence of high densities of brown treesnakes has limited recovery efforts to reestablish the Mariana crow, Guam Micronesian kingfisher, and Guam rail populations in the wild on Guam.

In 2014, the USDA-APHIS Wildlife Services, in coordination with the National Wildlife Research Center, the DoD-Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs, conducted a test of aerial application of a brown treesnake toxicant (acetaminophen) over forested areas in AAFB (Dorr et al. 2014, unpublished data). The results of this study indicated that development of a scalable automatic bait application system could be used in the near future for large landscape scale brown treesnake control and suppression (Dorr et al. 2014, unpublished data). This significant development makes reintroduction of the extirpated avian species a real possibility on Guam (USFWS 2015c). As control efforts continue, we expect that the Guam Micronesian kingfisher, Mariana crow, and Guam rail will be re-introduced onto Guam in the foreseeable future (L. Mehrhoff, USFWS, pers. comm. 2013). With the potential for brown treesnake to be controlled, it is imperative that a sufficient area of forested habitat be conserved in Guam to allow for recovery of these species (USFWS 2015c).

Control of brown treesnakes on DoD lands

The DoD has a long history of working cooperatively with natural resource agencies and stakeholders to prevent the dispersal of brown treesnakes to other Pacific islands and refine techniques to control snakes on Guam. As mentioned above, the DoD and the DOI have recently supported the successful development and application of an aerially dispersed toxicant to control brown treesnake numbers over a landscape on Guam. The DoD also provides funding and support to USDA Wildlife Services to maintain active snake traps around air and sea ports, and housing on DoD lands. As a requirement of a Biological Opinion, the DoD also maintains active snake traps in areas adjacent to the Mariana swiftlet caves at the NMS. The goal is to decrease brown treesnake numbers in swiftlet habitat and reduce the predation of swiftlets by snakes. Because swiftlet habitat within forested areas overlaps with habitat for the Guam Micronesian kingfisher, Mariana crow, Mariana fruit bat, and the Guam rail, snake trapping also benefits these species.

In fiscal year 2014, the DoD funded three projects that will explore methods to detect brown treesnakes and/or evaluate movement of snakes within a landscape. These projects potentially will provide information used to refine rapid response actions and brown treesnake eradication efforts. The DoD continues to work cooperatively with the Brown Treesnake Working Group to identify and implement future brown treesnake projects.

Climate Change

Climate models indicate that hurricanes in the northwestern Pacific are expected to increase in intensity, frequency, and duration by 2200 and continue to increase further into the future (Emanuel et al. 2008, p. 360). These storm increases will likely have a significant effect on habitat and survival of listed species on Guam. We do not expect that additional climate change features including increases in temperature, precipitation, and sea level (Australian Bureau of Meteorology and CSIRO 2011, Ch. 6, p. 178) will significantly affect listed species on Guam.

Environmental Baseline for the Guam Micronesian Kingfisher

Guam Micronesian kingfishers are extirpated from the action area; however, habitat suitable for the survival and recovery of the species (hereafter, kingfisher habitat) is present. For purposes of this Biological Opinion, the "survival condition" of the kingfisher in the wild represents the level of reproduction, numbers, and distribution necessary to support a persistent population on Guam that is fully protected by the ESA. For purposes of this Opinion, the "recovery condition" of the kingfisher is the survival condition where the threats to the species have been addressed such that the protections of the ESA are no longer necessary to ensure perpetuation of the survival condition of the kingfisher in the wild on Guam. Under those circumstances, the kingfisher would qualify for de-listing under the ESA.

As further described below, the role of the action area for the survival and recovery of the Guam Micronesian kingfisher is to provide protected habitat sufficient for two recovery populations (one in north Guam and one in south Guam) of sufficient size to each support 500 territorial breeding pairs in habitat where threats are managed and controlled. Because DON lands within the action area include approximately 75 percent of the kingfisher's habitat in northern Guam, and 43 percent in southern Guam, protection of habitat sufficient to help support two subpopulations (one in northern Guam and one in southern Guam) on DON lands in the action area is essential to the survival and recovery of the kingfisher.

Rationale for Delineation of Guam Micronesian Kingfisher Habitat

Survival and recovery of the Guam Micronesian kingfisher has required maintaining a population in captivity while threats from the brown treesnake are addressed on Guam. Retaining lands containing kingfisher habitat on Guam is essential for recovery and survival of the species. The success of such efforts is dependent on protecting a sufficient amount of habitat within the kingfisher's historical range to support two subpopulations of kingfishers upon reintroduction to northern and southern Guam.

Recently, we updated and conducted a detailed habitat assessment for the Guam Micronesian kingfisher on Guam (USFWS 2015c). Our goals were 1) to identify lands suitable for reintroduction of the species; 2) to determine how much habitat was needed to support survival and recovery of the species, based on the kingfisher recovery plan criteria (USFWS 2008a, p. vi); and 3) to develop a method to offset loss of remaining habitat so that a minimum amount of habitat needed to support the species is permanently protected. The methods used to calculate kingfisher habitat are provided below.

Methods for Habitat Calculations for the Guam Micronesian Kingfisher

Recovery Targets
The recovery plan for the Guam Micronesian kingfisher (USFWS 2008a) requires the following criteria to be met for delisting. First, there must be two subpopulations of at least 1,000 adult kingfishers (one in northern and one in southern Guam). In addition, both populations must be either stable or increasing based on quantitative surveys or demographic monitoring that demonstrates an average intrinsic population growth rate of greater than 1.0 over a period of at least 10 consecutive years. Third, sufficient habitat, based on quantitative estimates of territory and home range sizes, must be protected and managed to support the population size and trajectory criteria identified above. Finally, brown treesnakes and other introduced predators need to be controlled over 10 consecutive years at a level sufficient to achieve the first and second criteria, above.

Habitat needed to support the Guam Micronesian kingfisher survival and recovery
The following analysis was completed to determine the amount of kingfisher habitat on Guam that must be protected and managed to support both the survival and recovery of this species. This analysis relies on known and estimated life history requirements of the kingfisher and closely related species, and the findings in the final revised recovery plan for the kingfisher (USFWS 2008a).

Delineation of Survival and Recovery Habitat
As noted in the Status of the Guam Micronesian Kingfisher section above, kingfishers utilize a mosaic of forested and open habitats for foraging and breeding. However, as forested habitats, especially mature forest, are likely limiting, the analysis focused on identifying forested habitats as recovery habitat for the kingfisher. This approach was taken for two reasons. First, kingfishers need forested habitat for breeding, so forested habitat is essential to the species. Second, typhoon impacts to forested habitat are not well understood. Therefore, by focusing on forested habitats we provide a more conservative estimate of kingfisher habitat needed for its survival and recovery in the wild on Guam.

All areas identified as limestone, ravine, coconut, and palma brava (*Heterospathe elata*) forests in the 2006 Forest Service landcover map of Guam (Liu and Fischer 2006) were considered to be potential kingfisher habitat. The amount of available habitat was updated by removing all forested areas cleared since the landcover map was completed. This process used 2011 satellite imagery of Guam (USFWS, unpublished data) and other reported clearing (USFWS, unpublished data).

The remaining forested areas were subdivided into potential and non-potential recovery habitat based on forest patch area and isolation. Forest areas that were sufficiently large to hold a kingfisher territory were identified using a "territory building" algorithm (USFWS unpublished algorithm) developed using the Raster package (Hijmans 2014) in the statistical program R. This algorithm accounted for the size of the territory and percentage of forested habitat per territory, thereby omitting areas that were insufficient in size or placement of forested habitat to meet the criteria of a kingfisher territory. We classified forest patches as too isolated for recovery habitat if they were of insufficient size to hold three or more territories and if they were greater than

0.87 mile (1.4 km) (the maximum dispersal distance reported by Kesler and Haig 2007c for the Pohnpei Micronesian kingfisher) from the nearest neighboring forested area supporting three or more territories. The results of these analyses indicate that there are approximately 14,997 acres of kingfisher habitat in northern Guam and 13,314 acres of kingfisher habitat in southern Guam.

Estimated Population Size and Area Needed for Recovery

1. Each breeding kingfisher pair requires 20 acres of habitat (Kesler and Haig 2007a, Pohnpei subspecies of the Micronesian kingfisher). Therefore, under ideal conditions 10,000 acres of habitat will be needed to support a stable kingfisher population with 500 breeding pairs in northern Guam, where the breeding pairs are using 100 percent of the habitat throughout the year, the habitat is in ideal condition to support kingfishers, and there is never any loss of habitat due to manmade or natural disturbances such as fires or storms. These ideal conditions are unrealistic and not sustainable. Consequently additional area is needed for a more realistic estimate of kingfisher recovery habitat, as follows.

2. Density estimates for Guam Micronesian kingfisher in undeveloped areas of northern Guam give an average density of 4 acres per bird (adults and juveniles; calculated with data from northern Guam for the Guam subspecies of the Micronesian kingfisher in Engbring and Ramsey 1984). Thus, the 10,000 acres will actually support 2,500 adult and juvenile kingfishers. This density estimate includes areas that are periodically not used as territories, but are an integral part of the kingfisher habitat, allowing for natural disturbances such as storm, tree falls, landslides, etc.

3. A stable age distribution with 1,000 adult kingfishers gives a population comprised of 38.24 percent adults (calculated with data on the Tuamotu subspecies of the Micronesian kingfisher in Kesler et al. 2012). Thus, 38.24 percent of 2,500 birds are 956 adults, equaling 478 breeding pairs in 10,000 acres; each pair requiring approximately 21 acres (10,000 acres ÷ 478 pairs). An additional 22 breeding pairs (44 adults) are needed to reach the recovery threshold of 500 breeding pairs (1,000 adults). An additional 462 acres of habitat is needed for these 22 breeding kingfishers. Thus the total habitat needed to support 1,000 adults (500 breeding pairs) is 10,462 acres.

4. The 10,462 acres supports the minimum number of breeding kingfishers needed to reach recovery, and does not provide for natural population fluctuations below the recovery threshold. For instance, climate change is predicted to increase the frequency, intensity and duration of storms in the area of the Mariana Islands by several percent over the next 100 years (Emanuel et al. 2008, p. 360); this will likely increase the fluctuation of the northern Guam kingfisher population. To prevent the kingfisher population from fluctuating below the recovery threshold, additional habitat is required for protection against current and future severe storms. Severe storms (strong - category 3 and above - typhoons and super-typhoons) currently affect Guam once a year on average (FWS analysis of the Joint Typhoon Warning Center best track data 1975-2014). Climate modeling indicates that these storms will increase in the future. A single severe storm can affect habitat, survival, and reproduction. A 10 percent increase in breeding pairs (50 pairs) requiring an additional 1,050 acres of habitat will serve as added protection against

population fluctuations due to climate change and other unforeseen natural and manmade events.

5. The area needed to support a viable northern Guam kingfisher subpopulation that maintains itself above the minimum recovery threshold is estimated to be 11,512 acres. This minimum area assumes that the habitat is restored and managed as follows: restoration of kingfisher habitat requires establishing land cover to 56 percent forested that support trees greater than 17 inches in diameter, and 44 percent open or low cover areas for foraging; management of kingfisher habitat requires the continual control of invasive plants, ungulates, non-native predators such as the brown treesnake, rats, and cats, as well as protection from fire. These restoration and management activities have never been fully demonstrated on Guam and so their success remains an assumption. Predator, weed and ungulate control activities can be very difficult in open wilderness terrain where access and monitoring are difficult. Because of this uncertainty in restoration and management of kingfisher habitat, additional habitat beyond the 11,512 acres may be required to achieve the recovery of kingfisher in northern Guam. This minimum recovery area (11,512 acres) also assumes that at least 1,000 adults are breeding, thus 500 breeding pairs. The area requirements for a breeding pair (approximately 20.0 acres; Kesler and Haig, 2007a) is less than the combined area for an individual non-breeding adult male (average of 17.5 acres; Kesler and Haig 2007a) and an individual non-breeding adult female (average of 14.1 acres; Kesler and Haig 2007a). Thus the total area for recovery will be minimized by assuming all 1,000 adults are in breeding pairs. Additional area may be needed if a significant number of adult kingfishers forgo breeding in any year.

Estimated Amount of Habitat Needed to Support Kingfisher Survival and Recovery
Based on the above analysis, the final area needed to support a viable Guam Micronesian kingfisher population that maintains itself above the minimum recovery threshold is estimated to be 11,512 ac for each kingfisher subpopulation in northern and southern Guam. Collectively, a total of 23,024 ac of habitat would be needed to support the survival and recovery of the kingfisher on Guam (Figure 6).

Summary of Remaining Habitat to Support the Survival and Recovery of Kingfishers on Guam

We estimate that there are currently 14,997 ac and 13,314 ac of kingfisher habitat in northern and southern Guam, respectively. However, kingfishers excavate nest cavities in trees over 17 inches in diameter that are located in closed canopy forests with dense understory vegetation, and this habitat type is limited on Guam due to extensive forest clearing and ungulate effects to forest regeneration. Additionally, natural disturbance events, such as severe typhoons, will continue to affect the availability of the large forest trees necessary to support kingfisher nesting, and these typhoons are expected to increase in intensity, frequency, and duration (Emanuel et al. 2008, p. 360). Therefore, while it currently appears there is adequate potential habitat to support kingfisher survival and recovery, the actual suitable habitat is likely less; thus any loss of potential habitat must be carefully considered in regards to whether it appreciably reduces the likelihood of kingfisher survival and recovery in the wild.

For kingfisher habitat to support the survival and recovery of kingfisher, much of it will likely have to be restored, and all of it will have to be managed. Restoration of kingfisher habitat requires establishing land cover to approximately 56 percent forested that support trees greater than 17 inches in diameter, and approximately 44 percent open or low cover areas for foraging. Management of kingfisher habitat requires the continual control of invasive plants, ungulates, non-native predators such as brown treesnakes, rats, and cats, as well as protection from fire. Predator, weed and ungulate control activities can be very difficult in open wildness terrain where access and monitoring are difficult. Because of the uncertainty in restoration and management of kingfisher habitat, the Service developed a mitigation ratio to ensure kingfisher habitat to support the recovery of kingfisher on Guam would be protected and conserved (USFWS 2015c).

Mitigation Framework
In consideration of the on-going and increased habitat loss and degradation on Guam (as detailed in the General Environmental Baseline section) the Service has endeavored to finalize the draft Mitigation Framework (USFWS 2014e), including the mitigation ratio for habitat loss, to address future habitat conservation needs for the Guam Micronesian kingfisher (USFWS 2015c). As land management actions are proposed that will affect habitat needed for the recovery and survival of the kingfisher, it will be necessary to offset these effects by assuring that durable habitat will be protected and available for species reintroduction. This can be accomplished by ensuring that any habitat that is lost is offset with permanent habitat conservation at rates that ensure an adequate amount of habitat is needed to support the survival and recovery of the kingfisher on Guam.

The mitigation ratio took into account kingfisher habitat that was already protected in northern and southern Guam. For northern Guam, approximately 571 acres of kingfisher habitat is protected. There is no kingfisher habitat protected in southern Guam. Kingfisher habitat should be protected to the maximum extent possible until restoration and management practices for kingfisher habitat are proven to work.

The Mitigation Framework provides guidance to ensuring that adequate amounts of the habitat will be available for species reintroduction in the future. We have recommended to the DON that they should assure that any habitat that is lost as a result of proposed projects is offset with permanent habitat conservation at a rate that ensures the minimum amount of habitat needed to support kingfisher conservation will ultimately be available to support the recovery and survival of the species in the wild on Guam. Although not part of the project description, please refer to the MOA (DON and USFWS 2015), for information on kingfisher habitat that will be protected to ensure the survival and recovery of the kingfisher on Guam.

Environmental Baseline for the Mariana crow

Mariana crows are extirpated from the action area; however, habitat potentially suitable for the survival and recovery of the species (hereafter, crow habitat) is present. For the purposes of this biological opinion, the "survival condition" of the Mariana crow in the wild on Guam represents the level of reproduction, numbers, and distribution of each species that is necessary to support a persistent population on Guam. Achievement of the survival condition is facilitated by recovery planning and the protections afforded to listed species under the ESA. For purposes of this

biological opinion, the "recovery condition" of these species is the survival condition where the threats to the species have been addressed such that the protections of the ESA are no longer necessary to ensure perpetuation of the survival condition of the listed species in the wild on Guam and Rota. Under those circumstances, the species would qualify for de-listing under the ESA.

As further described below, the role of the action area for the survival and recovery of the Mariana crow is to provide protected habitat sufficient for two recovery populations (one in north Guam and one in south Guam) of sufficient size to each support 100 territorial breeding pairs in habitat where threats are managed and controlled. Because DON lands within the action area include approximately 75 percent of the Mariana crow's habitat in northern Guam, and 43 percent in southern Guam, protection of habitat sufficient to help support two subpopulations (one in northern Guam and one in southern Guam) on DON lands in the action area is essential to the survival and recovery of the Mariana crow.

Rationale for delineation of crow habitat

Survival and recovery of the Mariana crow has required maintaining a population off-island or in captivity while threats from the brown treesnake are addressed on Guam. Retaining unoccupied habitat on Guam is essential for recovery of the species. The success of such efforts is dependent on protecting a sufficient amount of habitat within the Mariana crow's historical range to support a crow population upon reintroduction.

We conducted an updated detailed habitat assessment for the Mariana crow on Guam (USFWS 2015c). Our goals were 1) to identify lands suitable for reintroduction of the two species; 2) to determine how much habitat was needed to support survival and recovery of the species; and 3) to develop a method to offset loss of remaining habitat so that a minimum amount of habitat needed to support the species is permanently protected. The methods used to calculate crow habitat are provided below.

Methods for Habitat Calculations for the Mariana Crow

Recovery Targets
The delisting criteria from the draft revised recovery plan for the Mariana crow calls for a minimum of 225 territorial breeding pairs (75 on Rota, 75 in northern Guam, and 75 in southern Guam) (USFWS 2005a, p. v). Since the draft revised recovery plan was published in 2005, additional work on population viability of the Mariana crow has occurred. This recent assessment of population viability indicated that 75 territorial breeding pairs may not be viable over the long-term due to potential inbreeding depression (O'Grady et al. 2006) and projected increases in tropical storm intensity, duration, and frequency (Emanuel et al. 2008), and that 100 territorial breeding pairs may be a more appropriate recovery target (Amidon 2012, unpubl. data). Therefore, we used 100 territorial breeding pairs as our recovery target for this assessment for each of the three regions identified above.

A sustainable population of territorial pairs requires a floater population of juvenile and pre-breeding Mariana crows to replace any pair members that die. We utilized demographic information from the Rota population (Morton et al. 1999, Ha et al. 2010b, Zarones et al. 2013)

to estimate a stable age distribution using the popbio package (Stubben and Milligan 2007) in the statistical program R (R Core Team 2014). We then used this distribution to determine the number of non-breeders needed to support the breeding population. Based on this analysis, an additional 96 adult Mariana crows (males and females), 54 juveniles and 42 pre-breeders, would be needed to support a breeding population of 100 territorial pairs at each of the three areas described above. We assumed that each of these birds would require space for foraging and roosting.

Finally, the long-term stability of the Mariana crow population is dependent on the availability of suitable breeding habitat and successful reproduction. Typhoons are a regular occurrence on Guam and Rota and are expected to affect the availability of suitable nesting sites and overall nesting success. Unfortunately, estimates of typhoon damage to nesting trees and demographic estimates of typhoon impacts on Mariana crow breeding success are limited. This assessment should be reconsidered when these data become available. In the interim, we will use more conservative estimates of habitat requirements and delineation of habitat areas (see below) to help account for some of these effects.

Density Estimates
Morton et al. (1999, p. 2) reported that Mariana crow territories ranged from 29.65 to 91.43 ac on Rota, with a mean territory size of 54.36 ac. Therefore, we utilized 54.36 ac as our estimate of forested habitat needed to support a breeding pair. Home range estimates for non-breeders were not available, and we do not currently have information on Mariana crow territory overlap. Therefore, we assumed that each bird would need approximately half a territory, 27.18 ac (11 ha).

Delineation of Crow Habitat
As noted above, Mariana crows are more likely to occur in native dominated forest. For this assessment, we assumed that all areas identified as limestone and ravine forests on the 2006 Forest Service landcover maps of Guam and Rota (Liu and Fisher 2006a,b) are potential Mariana crow habitat. We then updated the amount of available habitat on Guam by removing all forested areas cleared since the landcover map was completed using 2011 satellite imagery of Guam (Metevier 2014, unpubl. data). We then subdivided the remaining forested areas into potential and non-potential habitat based on forest patch area and isolation. We identified forest areas that were sufficiently large to support a Mariana crow territory using a "territory building" algorithm that we developed using the Raster package (Hijmans 2014) in the statistical program R. This algorithm accounted for the size of the territory and suitability of habitat, thereby omitting areas that were insufficient in size to meet the criteria of a Mariana crow territory. We then classified forest patches as too isolated for crow habitat if they were of insufficient size to hold three or more territories and if they were greater than 3.5 kilometers (the maximum dispersal distance reported by Ha (2012, *in litt.*) for the Mariana crow on Rota) from the nearest neighboring patch of forest capable of supporting three or more territorial pairs. Remaining habitat for the Mariana crow is shown in Figure 7.

Estimated Crow Habitat Needed
Utilizing the recovery targets for the species and density information, approximately 5,436 acres of forest is needed to support 100 territorial breeding pairs. In addition, 2,609 acres of forested habitat would be needed to support the non-breeding crow population. Therefore, a total of

8,046 acres of forest habitat would be needed at each of the three regions (Rota, northern Guam, and southern Guam) to support the survival and recovery of the Mariana crow. However, the 8,046 acres supports the minimum number of breeding Mariana crows needed for survival and recovery of crows in the wild, and does not provide for natural population fluctuations below the recovery threshold. For instance, climate change is predicted to increase the frequency, intensity, and duration of storms in the area of the Mariana Islands by several percent over the next 100 years (Emanuel et al. 2008, p. 360), and this will likely increase the fluctuation of the northern Guam Mariana crow population and increase the acres of suitable habitat needed for the survival and recovery of the crow.

To prevent the crow population from fluctuating below the recovery threshold, additional habitat is required for protection against current and future severe storms. Severe storms (strong [category 3 and above] typhoons and super-typhoons) currently affect Guam every five to 10 years (FWS analysis of the Joint Typhoon Warning Center best track data 1975-2014). Climate modeling indicates that these storms will increase in the future (Emmanuel et al. 2008, p. 360). A single severe storm can significantly affect survival and reproduction in that breeding season. A 10 percent increase in breeding pairs (10 pairs) requiring an additional 544 acres of habitat will serve as added protection against population fluctuations due to climate change and other unforeseen natural and manmade events.

Based on the above analysis, the final area needed to support a viable Mariana crow population that maintains itself above the minimum recovery threshold is estimated to be 8,590 ac for each Mariana crow subpopulation in northern and southern Guam.

Remaining Crow Habitat on Guam

There is currently 13,962 acres of potential Mariana crow habitat left in northern Guam. However, very little of this remaining habitat is set aside for conservation (a total of 502 acres), and even less of that habitat is managed to control threats. There is currently 10,957 acres of Mariana crow habitat left in southern Guam. No crow habitat in southern Guam is set aside for conservation or managed to control threats.

In addition to lands being set aside for conservation, crow habitat needs to be managed for threats including brown treesnakes and other predators, invasive species, and ungulates. Most of the lands set aside for conservation are not currently managed to reduce threats. Therefore, it is urgent that habitat protection and management of Guam's forests begin immediately to prepare for the reintroduction, and potential recovery, of extirpated avian species. If crow habitat is degraded enough to no longer provide the ecological functions necessary to support Mariana crows (for example, loss of native trees necessary for crow breeding and foraging), then this habitat will need to be removed from baseline calculations.

Furthermore, the habitat model does not account for differences in habitat quality. As described above, primary limestone forest is the highest quality habitat for the Mariana crow. Secondary limestone forest is of lower quality, but due to data mapping challenges, is counted equally in the habitat model. Given the current threats from military and civilian development, typhoons, invasive species, ungulates, and forest conversion, and the small amount protected habitat, it is

imperative that conservation efforts begin to protect and enhance the quality of Mariana crow habitat on Guam.

Mitigation Framework
In light of on-going and increased habitat loss and degradation on Guam (as detailed in the General Environmental Baseline section) the Service has developed a draft Mitigation Framework to address future habitat conservation needs for the Mariana crow (USFWS 2015c). As land management actions are proposed that will affect recovery habitat needed for the conservation of the Mariana crow, it will be necessary to offset these effects by assuring that durable habitat will be protected and available for species reintroduction. This can be accomplished by ensuring that any habitat that is lost is offset with permanent habitat conservation at rates that ensure the minimum amount of habitat needed to support the survival and recovery of the Mariana crow on Guam.

The Mitigation Framework provides certainty that adequate minimum amounts of the remaining habitat will be available for species reintroduction in the future. We have recommended to the DON that they assure any habitat that is lost as a result of proposed projects is offset with permanent habitat conservation at a rate that ensures the minimum amount of habitat needed to support crow conservation will ultimately be available to support recovery of the species. Although not part of the project description, please refer to the MOA (DON and USFWS 2015), for information on kingfisher habitat that will be protected to ensure the survival and recovery of the kingfisher on Guam. The habitat that will be protected pursuant to the MOA may also provide conservation benefit to the Mariana crow (DON and USFWS 2015, p.3).

Environmental Baseline for the Guam Rail

Guam rails are extirpated from the action area; however, habitat suitable for recovery of the species ("recovery habitat") is present. For the purposes of this Section 7(a)(2) analysis on a species extirpated from the action area, we define "survival" of the species in terms of the amount of habitat needed to support a target recovered Guam rail population and "recovery" of the species as a point when this population is present on recovery habitat on Guam.

Rationale for delineation of recovery habitat

Survival and recovery of the Guam rail has required maintaining a population off-island or in captivity while threats from the brown treesnake are addressed on Guam. Retaining unoccupied habitat on Guam is essential for the recovery and survival of the species. The success of such efforts is dependent on protecting a sufficient amount of habitat within the rail's historical range to support a viable rail population upon reintroduction on Guam.

Methods for Recovery Habitat Calculation for the Guam rail

Recovery Targets
Before the Guam rail is considered for downlisting from endangered to threatened, the repatriation of 1,000 birds to northern Guam and 1,000 birds to southern Guam (total = 2,000 individuals; USFWS 1990a, p. 33) would need to occur and brown treesnakes would need to be controlled on Guam (USFWS 1990a, p. 33-34). As mentioned above, no criteria were defined

for delisting. However, Traill et al. (2009) proposed a minimum population target of 5,000 individuals as an appropriate target for species conservation.

Density Estimates
Engbring and Ramsey (1984) estimated Guam rail densities 0.07 to 0.33 birds per ha on Guam in 1981. The weka (*Gallirallus australis*), another rail species of conservation concern, had densities ranging from 0.3 to 0.8 birds per ha (Beauchamp 1987) while the Cocos buff-banded rails (*Gallirallus philippensis andrewsi*) typically had densities from four to nine birds per ha (Reid and Hill 2005). The Guam rail and weka densities both reflect species undergoing population declines. Therefore, their density estimates may not reflect the potential densities that could be obtained from a recovered population. However, because the maximum Guam rail density does overlap with the weka estimates it does serve as a good conservative estimate of potential densities until further data are collected. Therefore, to meet the population goal of 5,000 individuals on Guam we would need 41,184 ac (16,667 ha) (5,000 birds/0.3 birds per ha) of appropriate habitat on Guam. In addition, to meet the downlisting criteria of 1,000 birds in both northern and southern Guam then 8,236 ac (3,333 ha) (1,000 birds/0.3 birds per ha) of appropriate habitat would be needed in both northern and southern Guam.

Delineation of Recovery Habitat
Guam rails were predominately observed using scrubby secondary growth areas and the edges of mixed forest areas (Jenkins 1979, Engbring and Ramsey 1984). Jenkins (1979) reports that they were seldom observed in the interior of mature limestone forests or savanna areas and did not occur in wetlands. The Forest Service vegetation map of Guam includes the following vegetation types: 1) Limestone Forest, 2) Ravine Forest, 3) Palma Brava Grove, 4) Scrub Forest, 5) Leucaena Stand, 6) Casuarina Thicket, 7) Acacia Plantation, 8) Coconut Plantation, 9) Savanna Complex, 10) Strand Vegetation, 11) Other Shrubs and Grasses, 12) Agricultural Field, 13) Urban Builtup, 14) Urban Cultivated, 15) Barren Land, and 16) Wetlands (Liu and Fischer 2006a). Of these vegetation types, only Scrub Forest, Other Shrubs and Grasses, and Urban Cultivated were considered primary Guam rail habitats because they include shrubby edge habitats. The remaining forested areas were excluded because rails were less common in interior forested areas. Rails are thought to use the edges of these vegetation types, however, these areas are likely bordered by secondary scrub, shrub, and urban cultivated vegetation types which are included. Savanna complex also was not included though they may use the edge of this habitat types. Wetlands and barren lands were not included because the available data does not list these vegetation types being used by rails. Guam rails may use agricultural fields however there was no data available indicating they use these areas. Finally, Urban Builtup was excluded because rails were not reported in urban areas and these areas likely do not contain appropriate habitat for the species.

In addition to vegetation type, patch size and proximity or distance between patches also were considered in the delineation of recovery habitat for the Guam rail. No information is available on the average size of a Guam rail territory. A related species, Lord Howe woodhens (*Gallirallus sylvestris*) have an average territory size of one to four ha (NSW National Parks and Wildlife Service 2002) while the weka (*Gallirallus australis*) have an average territory size of two or five ha depending on location (Beuchamp 1987). If we are conservative and assume the maximum territory of a Guam rail is similar to the weka then any patch less than 10 ha (the average territory size of two weka pairs [5 ha x 2]) and over one kilometer away from the nearest

patch is likely too small and isolated to be viable habitat for rail recovery. In addition, all patches less than one ha (the minimum territory size of a Lord Howe woodhen) and 125 meters (the approximate radius of a five ha territory) from the nearest patch above one ha is considered too isolated and small to be viable habitat for rail recovery. Finally, any patch less than 10 ha and completely isolated by the nearest patch by lands classified as Urban Builtup (excluding roads) by the Forest Service is considered too isolated to be viable rail habitat due to the potential for urban developed areas to impede movement of rails. The remaining recovery habitat for the Guam rail is shown in Figure 8.

Estimated Recovery Habitat Needed
Based on the density information and the population goal of 5,000 individuals on Guam to achieve conservation of the Guam rail, we would need 41,184 ac (16,667 ha) (5,000 birds/0.3 birds per ha) of appropriate habitat on Guam. In addition, to meet the downlisting criteria of 1,000 birds in both northern and southern Guam then 8,236 ac (3,333 ha) (1,000 birds/0.3 birds per ha) of appropriate habitat would be needed in both northern and southern Guam.

Remaining Recovery Habitat on Guam

Based on the above, there are approximately 24,698 ac (9,995 ha) and 24,886 ac (10,063 ha) of recovery habitat in northern and southern Guam, respectively, for the Guam rail. However, very little of this habitat is protected for the conservation of the Guam rail. Although a quantitative habitat assessment of the protected areas for use by Guam rails has not been conducted, approximately 500 acres have been protected for the Mariana crow and Guam Micronesian kingfisher in northern Guam (USFWS 2015c, p. 3). Rails would be expected to use much of the edges of forest patches, secondary forest and scrub within the approximately 500 acres of protected habitat. No recovery habitat in southern Guam is set aside for conservation.

In 2012, the GNWR proposed approximately 125 acres of habitat on the GNWR's fee simple land to be managed for Guam rails. This area would eventually support the reintroduction of Guam rails within the GNWR. However, this proposal was put on hold in 2014 because of the DON's proposed establishment of the LFTRC surface danger zone within the fee simple land. The GNWR is in the process of evaluating the feasibility of this proposal and whether to move forward with it, in consideration of the proposed action and the future access constraints to the GNWR (J. Schwagerl, USFWS, pers. comm. 2015).

Lands set aside for conservation on Guam and recovery habitat needs to be managed for threats including brown treesnakes and other predators, invasive species, and ungulates. Most of the lands set aside for conservation are not currently managed to reduce threats. In addition, the loss, degradation, and fragmentation of recovery habitat due to urban development continues to threaten the Guam rail.

Environmental Baseline for the Mariana fruit bat

Mariana fruit bat population on Guam

Other than a few isolated periods of increase, Mariana fruit bats have been declining on Guam since the early 1900's (Wiles 1987b, p. 1; USFWS 2009d, pp. 6–7 and references cited therein). Although the decline of the fruit bat was likely initiated by the introduction of firearms and

increased hunting efficiency in the early 1900's, predation by brown treesnakes contributed to continued decline (Wiles et al. 1987, p.148; Lemke 1992, p. 137; Wiles et al. 1995, p. 32; Janeke 2006, p. 3; Brooke 2008, p. 2; USFWS 2009d, p. 19, 30). By 1995, nearly all of Guam's remaining fruit bats were located on AAFB (Wiles et al. 1995, p. 39). In 2006, the only known maternity colony on Guam was located on AAFB at Pati Point and had less than 100 individuals (Janeke 2006, p. 4). By 2010 the Pati Point colony no longer existed, and no other colonies are known to currently exist on Guam (SWCA 2012, p. 20, DON 2014c, p. 2).

In December 2015, bats were observed within HMU at AAFB on Guam. Preliminary estimates were 30 to 50 bats present within the HMU (D. Lujan, AAFB, pers. comm. 2016). Bats have been regularly using the forest of the HMU for foraging and roosting. According to direct observation and indirect evidence of fruit bats, the fruit bats appear to be using most of the interior forested area in the HMU. Four different fruit bat roosting locations were identified during three perimeter and eight interior surveys of the HMU. The largest group of bats counted in one area was 112 bats. Bats are also observed flying from and to adjacent areas outside of the HMU (Mildenstein 2016). It is possible that the bats at HMU represent a breeding colony on Guam (DON 2016x).

As described below, individual bats have been detected at multiple locations on Guam in the past eight years (Figure 9):

Northern Guam (GNWR, AAFB, Finegayan, and Haputo)

- In December 2015 -February 2016, bats were observed within the HMU on AAFB. It is estimated that 112 bats are present within a colony at the HMU.
- In July 2014, a large-scale survey throughout AAFB resulted in an estimate of 8-21 bats (DON 2014c, p. 2).
- Surveys on AAFB in 2012 recorded 50 detections of bats at 84 stations, some of which could be the same individuals. Bats were primarily recorded along the cliffline extending from above the Combat Arms Training and Maintenance (CATM) Range east to Pati Point, in the MSA, and in the vicinity of the HMU (SWCA 2012, p. 58).
- In 2011, three bats were observed flying west along the beach in front of the headquarters at GNWR (Schwagerl, pers. comm., 2015).
- Extensive surveys throughout AAFB from December 2010 to December, 2011, resulted in a conservative estimate of approximately 25 fruit bats (DON 2014c, p. 48)
- From 2010-2013, a single bat was observed flying across Route 3A on six occasions; four observations of a bat flying into the HMU from Finegayan, and two observations of a bat flying out of the HMU into Finegayan in the late afternoon (J. Schwagerl, USFWS, pers. comm. 2015). Fruit bats from AAFB may use forested areas of Finegayan for foraging and roosting.
- During 10 observation days in 2008, one fruit bat was observed in the Haputo ERA and one in the northeastern portion of Finegayan (Brooke 2008, p. 1). The Haputo ERA contains some of the best remaining fruit bat habitat on the DON-managed lands (Brooke 2008, p. 2; DON 2010c; DON 2013b).

Naval Magazine, Naval Base Guam, and Southern Guam

- In August, 2014, two observations of a Mariana fruit bat in flight occurred at Fena Reservoir within the NMS (L. Takano, USFWS, pers. comm. 2014).
- In May and June of 2012 seven detections of a single fruit bat were recorded during surveys on six separate occasions at four locations on the NMS; it could not be determined whether observations were of a single individual or multiple individuals (DON 2014a, p. 48).
- In 2012, fruit bat surveys were conducted within the NMS and a private lands site located in southern Guam (DON 2013b). Seven observations were recorded of a solitary fruit bat in flight at NMS, but it could not be determined if these observations represent one, or multiple bats (DON 2013b, p. 11). These observations supplement fruit bat sightings previously documented in the vicinity of the NMS where foraging and roosting habitat is present (Brooke 2008, pp 1-2). No observations were recorded at the private lands site where suitable fruit bat roosting and foraging habitat is limited. However, known food plants of Mariana fruit bats are present in the vicinity and fruit bats may use the area for roosting, foraging, and commuting (DON 2013b, p. 12).
- One bat was sighted on NBG lands in 2008 during 90 hours of fruit bat surveys at 14 survey locations on or near NBG lands. (DON 2014a, p. 48).

Threats to the Mariana fruit bat on Guam

In addition to the threats described in the General Environmental Baseline section, the following threats also affect Mariana fruit bat populations on Guam.

Hunting
Humans have been using Mariana fruit bats as a food source since human arrival in the Mariana Islands, and consumption of bats represents a significant Chamorro cultural tradition (Lemke 1992, p. 135; Sheeline 1991, p. 14). Demand for fruit bats for human consumption is clearly demonstrated by the large commercial trade in bats that existed in the Marianas in the late 1960's until it became illegal through the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES; Wiles and Payne 1986, p. 143; Stinson et al. 1992, p. 63-66; Wiles et al. 1997, p. 204; CITES 2015). It is estimated that approximately 221,000 fruit bats were imported to Guam between 1975 and 1989 (Wiles 1992, p. 54). Illegal hunting appears to be the key reason for the fruit bat's dramatic decline on Guam (Wiles 1987b, p. 154; Wiles and Brooke 2009; USFWS 2009d, p. vii).

Currently, although bats are protected by law on Guam, they are probably still hunted opportunistically on private property when they transit the island, and by deer hunters on AAFB (GNWR, unpublished data, 2005). For example, in 2007, construction of approach lighting at the north field on AAFB began, and included clearing of native limestone forest near Pati Point. During the construction period, reports were made of construction workers illegally hunting fruit bats at the Pati Point colony. The number of fruit bats at the colony declined from 55 bats (summer 2007) to 21 bats (December 4, 2008 survey) (PEER 2009). A recreational public hunting program has been in effect on AAFB since 1964, is still in effect (D. Lujan 2015, pers. comm.), and is managed by a small group of hunters known as the Volunteer Conservation Officers (VCOs). The public is authorized to hunt on weekends in designated areas, and VCOs may hunt after regular working hours during the week. All hunting effort is documented by the VCOs. Currently, archery-only hunting is allowed in four areas (D. Lujan 2015, pers. comm.);

shotgun and muzzle loading hunting is no longer allowed. Elimination of shotgun and muzzle-loading hunting is likely to reduce the chance of fruit bat hunting on AAFB; however, it is possible that fruit bats are still hunted opportunistically on AAFB. SWCA (2012, p. 58) reported that roosting fruit bats were approached by observers as close as 16 ft (5 m), and suggested that hunters could, without difficulty, shoot and kill a roosting bat.

Opportunistic hunting of fruit bats is suspected to occur during hunting of ungulates (Wiles 1987b, p. 154; Janeke 2006, p. 67; USFWS 2009d, p. 24; SWCA 2012, p. 60). In 2007, the Chief Conservation Officer (CCO) of the AAFB Hunting Program reported that poaching of deer was occurring in areas where hunting was not authorized. This same CCO issued Letters of Suspension to four VCOs, and a Removal from Program letter to one VCO for violations against Guam hunting regulations, Base Instructions and program depredation policies (PEER 2009).

Noise

Currently air traffic is the primary source of noise disturbance for fruit bats on Guam (SWCA 2008, p. 2-3; SWCA 2012, p. 23, 37). The first known study examining the effects of aircraft overflights on Mariana fruit bats on AAFB was conducted when a colony of approximately 400 bats still roosted at Pati Point (Morton 1996). During this study, roosting fruit bats responded to some low-altitude aircraft overflights with distress and flushing, which increased time spent in alert, aggression, and maintenance behaviors. Four-engine carriers and bombers generally elicited a greater response from roosting bats than fighter aircraft. Morton (1996, p. iii) suggested that higher levels of air-traffic volume would result in increased energy expenditure and perhaps roost abandonment by some or all of the bats.

In 2006, the effects on fruit bats from noise resulting from increased jet aircraft and helicopter use at AAFB were analyzed in the ISR Strike Biological Opinion (USFWS 2006b). In that consultation, noise effects were expected to adversely affect the Mariana fruit bat to the extent that the nearby Pati Point colony would be abandoned, and fruit bats relocating from Pati Point to other, less-protected areas on the island likely would be shot opportunistically by hunters (USFWS 2006b, p. 49). In the ISR Strike Biological Opinion, we concluded that fruit bats on Guam would be taken as a result of the proposed action, but that this take would not jeopardize the continued overall existence of the Mariana fruit bat (USFWS 2006b, pp. 49-52).

In 2007-2008, another study was conducted to document potential effects of aircraft noise on fruit bats at AAFB (SWCA 2008). During this period, the number of fruit bats at the Pati Point colony had decreased to an average of 40 bats. Aircraft noise affected the Mariana fruit bats by increasing maintenance behaviors following overflights compared to no overflights. However, the proportion of bats displaying maintenance behavior following an overflight was variable. Overflights did not appear to affect active thermoregulation. Six percent of overflights resulted in flushing events, and all flushing events were at noise levels exceeding 106 dBC, the highest reading being 122.6 dBC (SWCA 2008, pp. 2-3).

In 2010, another study was conducted to assess the effects of aircraft noise on Mariana fruit bats at AAFB (SWCA 2012). By 2010, the colony at Pati Point no longer existed. Although up to eight individual fruit bats were observed roosting there at any one time, most departed the site by the end of each sampling period, indicating the site was no longer used as a colonial roost (SWCA 2012, p. 2). Increases in active thermoregulation (32 percent), maintenance (14

percent), locomotion (74 percent), and alertness (62 percent) were recorded during aircraft overflights. All flush events were at recorded peak noise levels above 90 dBA/101 dBC; the highest reading at 124.9 dBA/125.5 dBC (two F-15 aircraft). The observed flush events were associated with fighter, bomber, transport, and helicopter aircraft overflights (SWCA 2012, p. 23, 37).

In 2015, the MITT Biological Opinion was signed (USFWS 2015b) and the Service found that implementation of the MITT program, including aircraft overflights and other training, was compatible with a fruit bat roost site at Pati Point, but noise caused by nighttime training activities would adversely affect the foraging behavior of fruit bats at AAFB and NMS.

Some evidence suggests that fruit bats may also be affected by artillery noise at the existing CATM range at Tarague. When the fruit bat colony was still roosting at Pati Point, a DAWR Wildlife Biologist observed fruit bats avoiding the firing range area as they left the roost to fly to their foraging grounds. Some flew away from land over the ocean, and returned to land by the Tarague beach area. Others flew up to the cliff line heading towards MSA I (ISR Strike area). These observations occurred while the firing range was active around on two different days. During the time period between the two observations, the number of bats in the colony dropped from approximately 40 to less than 20 individuals. When the firing range was inactive, bats were observed to fly along the cliff line near the range (J. Quitugua, DAWR, pers. comm. 2015).

Typhoons
Mariana fruit bats evolved in the presence of typhoons, the principal natural disturbance in the archipelago, but today these storms are a threat to the species because they can exacerbate the effects of the anthropogenic threats listed above (USFWS 2009d, p. 34). Evidence from Rota suggests that typhoons may not be a substantial source of direct mortality for fruit bats (Stinson et al. 1992, p. 65; Esselstyn et al. 2006, p. 536). However, the synergistic effect of illegal hunting and severe storms on Mariana fruit bats is documented on Rota (e.g., Stinson et al. 1992; Esselstyn et al. 2006). Severe storms can alter fruit bat foraging and roosting behavior by decimating food resources, removing protective foliage cover, temporarily modifying forest structure, and changing vegetation composition, especially by facilitating encroachment of non-native species. Loss of food resources can drive bats to forage on the ground, during daylight hours, and closer to areas of human activity; thereby increasing their vulnerability to illegal hunting (Stinson et al. 1992, p. 65; Esselstyn et al. 2006, p. 532).

Recovery Criteria

A draft revised recovery plan for the Mariana fruit bat (USFWS 2009d) addressed actions needed for the survival and recovery needs of the Mariana fruit bat. Since publication of the draft revised recovery plan, new information on the Mariana fruit bat has resulted in changes to how we look at recovery for the species. We now consider recovery in terms of stable or increasing subpopulations of sufficient size distributed across Guam and the Mariana Islands. To meet recovery objectives, stable or increasing fruit bat subpopulations should at a minimum be distributed on the islands that currently have extant populations (USFWS *in review*). Actions that reduce or eliminate the potential for self-sustaining populations of resident fruit bats on Guam may hamper or preclude recovery of the species. The reduction or elimination of this potential may take many forms: degradation or loss of habitat and resources required by the fruit

bat for foraging, roosting, and reproduction; increased exposure of fruit bats to illegal hunting and other sources of human disturbance; and introduction of non-native predators that prey upon fruit bats. In order for the Mariana fruit bat's population to recover on Guam, sufficient amounts of functional habitat will need to be protected and restored on Guam (USFWS 2009d).

Guam contains a large proportion of the remaining native limestone forest in the southern inhabited Mariana Islands, and most of that habitat is located within DOD lands. Habitat loss and degradation, illegal hunting, predation by non-native predators, and human disturbance currently impact fruit bats within the action area. If threat levels increase within fruit bat habitat in the action area, it may further inhibit the potential for the species to recover.

Mariana fruit bat survival and recovery habitat

Although Mariana fruit bats have been observed in a variety of habitat types, they are more likely to occur in native primary or secondary limestone forest (see Status of the Species above). Mariana fruit bat populations that have been subject to intense hunting pressure (e.g., populations on Saipan, Tinian, Rota, and Guam) are sensitive to human presence, and in recent history, maternity roosts are not known to occur in close proximity to areas inhabited by humans (Wiles 1987b, p. 151; J. Boland, unpublished data 2008-2014). However, fruit bats may forage on or near human-inhabited lands, in spite of hunting pressure (Wiles 2006, pers. comm. as cited in USFWS 2006b; Boland 2008-2015, pers. obs.). Therefore, for this assessment, we assumed that all areas identified as limestone and ravine forests on the 2006 Forest Service landcover maps (Liu and Fisher 2006a) are potential habitat for the fruit bat on Guam. We then updated the amount of available habitat on Guam by removing all forested areas cleared since the landcover map was completed using 2011 satellite imagery of Guam (Metevier 2014, unpubl. data). Although primary limestone forest is higher quality habitat that secondary limestone forest, habitat quality was not accounted for in these calculations due to mapping challenges, and habitat quality as it relates to hunting and predation threats was also not accounted for. As such, our estimate of available survival and recovery habitat (hereafter, referred to as habitat) on Guam is likely inflated.

Using the methods above, the total area of potential fruit bat habitat on Guam was estimated to be 27,096 acres (Figure 9). In order for native limestone forest to serve as habitat for the fruit bat, it will need to be managed for threats to the species, including brown treesnakes, illegal hunting, invasive plant species, and ungulates. Only 576 acres of this habitat is set aside for conservation. Most of the lands set aside for conservation are not currently managed to reduce threats. Therefore, it is urgent that habitat protection and management of Guam's forests begin immediately to allow for recovery of the Mariana fruit bat. If habitat is degraded enough to no longer provide the ecological services necessary to support the fruit bat, then this habitat will need to be removed from baseline calculations.

Mariana fruit bat densities

Estimates of bat density have been calculated for each of the Mariana Islands (DON 2013d, p. 46). The highest bat density is found on the most protected island, Asuncion Island, and is 1.81 bats per forest hectare. Rota has the highest bat population density in the southern part of the archipelago with 0.36 bats per hectare. Using calculations established by DON 2013d (p. 26,

45), and our estimate of 27,096 acres of existing fruit bat habitat, the estimated carrying capacity for fruit bats on Guam is 14,970 bats.

Environmental Baseline for *Serianthes nelsonii*

Rationale for delineation of recovery habitat

Recovery of the *Serianthes nelsonii* requires the permanent protection of sites that contain individuals of this species (USFWS 1994, p. 27). The target for delisting *S. nelsonii* (as described above) requires augmenting existing populations and reestablishing this plant in its former range (USFWS 1994, pp. 33-36). The conservation of recovery habitat is essential, not only to reaching this target, but to ensuring the continued survival and recovery of this species.

Methods for Recovery Habitat Calculation for *Serianthes nelsonii*

On Guam and Rota, *Serianthes nelsonii* trees were reported at elevations ranging from 120 to 420 meters (USFWS 1994, p. 7) and were found primarily in native dominated forests on limestone or volcanic substrates (Raulerson and Rinehart 1991, p. 42; USFWS 1994, pp 6-7; Wiles et al. 1996, p. 229). We therefore assumed that all remaining limestone and ravine forest, as classified by the U.S. Forest Service (Liu and Fisher 2006a), between 120 and 420 meters elevation were potential habitat for the species. Therefore, approximately 11,668 acres of habitat for *S. nelsonii* remains on Guam (Figure 10).

Status of the Species in the Action Area

The action area encompasses the entire adult population of *Serianthes nelsonii* on Guam, and is comprised of one adult tree of unknown age. The last remaining adult tree continues to produce seeds, but the structure and health of the tree itself is precarious due to a variety of factors (DON 2014a, p. 58; AAFB 2015, p. 4). The tree has begun to lean in recent years (AAFB 2015, p. 4), and there has been historical storm damage, including snapping and loss of branches (J. McConnell, UOG, pers. comm. 2014). It is at further risk of toppling due to termite damage, which is visible along the trunk, and a large amount of saprophytic or epiphytic ferns which have concentrated growth within a shallow cavity on the trunk (AAFB 2015, p. 4). In addition, the canopy of the tree has experienced recent extensive defoliation, probably due to insect herbivory from *E. blanda* butterflies (AAFB 2015, p. 4).

The area surrounding the fenced tree is comprised of rugged primary limestone karst forest. Although the area around the tree is currently fenced to prevent ungulate access, researchers are trying to understand why seedling mortality around this adult is close to 100 percent mortality (DON 2014, p. 11). Ungulate incidence and browsing is evident outside the small exclosure around the tree, as are nearby areas of past disturbance from military activities (e.g., clearings, ordnance). However, the heavily forested area around the adult tree is diverse with native plant species characteristic native limestone forests in the Marinas including, but not limited to, *Ochrosia mariannensis*, *O. oppositifolia*, *Eugenia reinwardtiana*, *Syzygium thompsonii*, *Macaranga thompsonii*, *Guamia mariannae*, and *Pisonia grandis*. Despite the presence of some pest species and habitat disturbance, the cliffline area surrounding the adult *S.*

nelsonii, especially the forested karst outcrops, is relatively undisturbed, high quality, diverse habitat suitable for multiple protected species, including *S. nelsonii*.

A large portion of the LFTRC footprint is in habitat currently being managed to eradicate ungulates. This area was designated as mitigation for a previous DoD action (USFWS 2006b), and falls within the Overlay Refuge. In addition, the DoD has several current projects and projects in the near future that may affect *S. nelsonii* habitat (refer to General Environmental Effects section).

As mentioned above, several recovery actions have been initiated recently for this species. However, the adult within the footprint of this action remains the sole reproducing tree on the island of Guam. The Guam adult tree is particularly important for maintaining the genetic diversity within this species (USFWS 1994, p. 21). In addition, the individuals outplanted at the GNWR within the proposed SDZ, are offspring of the Guam adult tree. They constitute much of the entire Guam genetic lineage of *S. nelsonii*, and all are within the proposed project's footprint. Their survival is crucial to maintaining genetic diversity of this species. The 31 outplanted individuals on GNWR, four months after outplanting, have 100 percent survival and all have experienced physical growth. However, daily monitoring, netting to exclude large insects, regular watering, small insect removal by hand, and other protective treatments were applied (E. Demeulenare, pers. comm. 2015).

Environmental Baseline for the Orchids (Orchidacea): *Bulbophyllum guamense, Dendrobium guamense, and Tuberolabium guamense*

Orchidacea are the most diverse of all the angiosperm families, with estimates of over 25,000 species (Dessler 1993, Mabberley 1997, Cribb et al. 2003). Orchids have highly specialized habitat and pollinator requirements, which not only contributes to its great species diversity but has also resulted in the high level of threat in this family (Cribb et al. 2003; Swarts and Dixon 2009, p. 544). Within the Mariana Islands, habitats are rapidly being destroyed by human activity (Raulerson and Rinehart 1992, p. 87).

Thirty species of orchids have been identified in the Mariana Islands; and four of the thirty are considered endemic to the Mariana Islands (Raulerson and Rinehart 1992, p. 87). Recently, the Service listed the four endemic orchids, *B. guamense*, *D. guamense*, *T. guamense*, and *Nervilia jacksoniae*, as threatened throughout their ranges (Service 2015, 73 pp). *B. guamense*, *D. guamense*, and *T. guamense* are epiphytes and grow on trees within the forest ecosystem.

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